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THE ROTIFERA OF THE SCOTTISH LOCHS.

BY

JAMES MURRAY.

[With Six Plates.]

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VII.—The Rotifera of the Scottish Lochs. By James Murray. Including descriptions of New Species by C. F. Rousselet, F.R.M.S., and D. Bryce, Esq. *Communicated by* Sir John Murray, K.C.B. (With Six Plates.)

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Introduction.

A necessary preliminary to the study of the complex problems involved in the biology of lakes is to ascertain the facts. The collection of the bathymetrical data was begun many years ago by Sir John Murray and Mr Pullar, and is nearing completion under the Lake Survey. The next thing is to take a census of the inhabitants. This we are now trying to do by compiling lists of the animals and plants living in the lakes. The study of the problems after the data are collected falls outside the province of a lake survey, and within that of some permanent biological station. This present compilation is one step in the accumulation of the facts.

This list of Rotifera observed in the Scottish lochs makes no claim to be exhaustive. A glance over it will show, to those competent to judge, where it is deficient, and how unequal is the treatment of the three orders represented. Records by other observers are not included. Gosse records many Scotch Rotifers, some of them lacustrine; Messrs W. and G. S. West, in their plankton papers, Calman (11), and others, in various publications, have made mention of limnetic Rotifers. Messrs Scott and Lindsay (47) give a list of nearly 100 species from one small loch. To Hood, more especially, one of the pioneers of the study of the Rotifera, who has brought to our knowledge so many beautiful and interesting forms, must be credited the discovery of a great many species in Scottish lochs. Mr Hood's records, however, are often unlocalised, being set down simply as from lakes and ponds in Scotland; and inasmuch as the list, even with his and other workers' records included, would still be far from exhaustive, it is judged best to make this simply a list of species observed by the Lake Survey, a contribution to the knowledge of lake Rotifera.

The compiler of the list having made a special study of one order, the Bdelloida, that order is treated with greater fulness than the others; the Rhizota and Ploïma might easily be added to if qualified naturalists were to make a special study of our lakes. In those orders a great many more species than are here recorded were actually seen, but many could not be identified. A fourth order, the Scirtopoda, did not occur at all in our collections.

The number of Rotifera now known to science is very great. The 400 species, or thereabouts, known to Hudson and Gosse (22) in 1889 have been continuously added to since, and probably at the present time more than twice as many are on record. No

doubt a sifting of the synonymy would lead to an appreciable reduction in the number; but, after all allowance is made, the Rotifers remain a numerous group. As they are, in the words of JENNINGS (26), "potentially cosmopolitan," a large proportion of the species may be expected in any part of the world where extreme climatic conditions do not prevail, if time and care are given to the quest.

As all are aquatic animals, a classification of them in relation to their surroundings may be made, thus:—First, those which live in permanent fresh waters; second, those which live in stagnant water; third, those which live where the supply of moisture is intermittent (moss-dwellers); fourth, those which live in the sea. The lochs are themselves the headquarters for the species which prefer pure water. The Scottish lochs derive a large proportion of their water directly or indirectly from peat-bogs, and with this water there may be carried into the lochs numbers of the swamp or stagnant-water species, which in many cases seem to find the new conditions congenial; the moss-dwellers also readily find their way into the margins of lochs, and thrive there. The number of marine Rotifers known is relatively small, though it is probable that more discoveries await the patient investigator in this direction than in any other.

In view of the great variety of conditions which our lochs present, the purity and moderate range of temperature of the deep ones, and the summer stagnation and wide range of temperature of many of the shallow ones, it might reasonably be expected that a sufficiently long-continued investigation would lead to the discovery of the majority of known Rotifers. Yet our list numbers only 177 species. It must be borne in mind, however, that the examination of most of the lochs was only partial, in the great majority restricted to the plankton, and that our list is founded mainly on a careful study of a single loch, and that a deep one. A similar study of some of the shallow lochs would undoubtedly greatly swell the list. Few investigations of the Rotifera of lakes in which the shore and bottom regions are studied equally with the plankton are available for comparison. Naturalists working on the lakes of the Continent of Europe have for the most part confined their attention to the plankton.

From the published accounts at my disposal I select two which offer the closest parallel to our own inquiry. JENNINGS, in his *Rotatoria of the United States*, gives special attention to the Rotifera of the Great Lakes (26); STENROOS in 1899 published an account of the Rotifera of a single lake, the Nurmijärvi-See (48). A comparison of the lists given by these two investigators with our own might seem unfair, since STENROOS confined his work to one lake, JENNINGS to a few great lakes, while the Lake Survey examined many hundreds, great and small. The inequality to a great extent disappears when we consider that JENNINGS did most of his work and found the great majority of his species in one lake, Lake Erie, and the Lake Survey in like manner found most of the species in Loch Ness.

JENNINGS (26) gives a total of 164 species from the Great Lakes; STENROOS (48) found 157 species in Nurmijärvi-See; the Lake Survey here records 177 species from the Scottish lochs—a singularly close correspondence in numbers in all three cases.

When we scrutinise the three lists carefully, however, and observe how greatly they differ in detail, how much richer the American list is in Rhizota (though admittedly deficient in that order) than either of the others, how much more numerous are the Bdelloida in the Scotch list, and how very few the Rhizota, it becomes evident that the coincidence in numbers is purely fortuitous. The Rhizota are not deficient in the Scottish lochs—they are particularly abundant, as Mr Hood's records show;* there is no reason to suppose that Bdelloids are scarce in the Great Lakes or in Finland—only that they have been less studied.

Confining the comparison of Stenroos's list to those compiled for the single lake most thoroughly examined by Jennings and by the Lake Survey, we see that the Finnish list is the most extensive. Stenroos got 157 species in Nurmijärvi-See, Jennings 132 in Lake Erie, the Lake Survey 148 in Loch Ness.

Loch Morar was visited several times, and 54 species were identified; 30 were noted in Loch Earn, 34 in Loch Tay. These numbers are merely an index to the time spent in the examination of the lochs, not to the number of species in them. There is no reason to doubt that the Rotifer-fauna of all our deep lakes is in the main identical; that of the shallow lakes on the whole richer, and locally more varied.

The classification of the Rotifera is in a chaotic state. Since the completion of Hudson and Gosse's monograph (22) in 1889, the number of known species has been doubled, and many of the new forms do not fit into the old divisions. New genera and families have been formed, and the old families redefined, to admit them; but a new monograph is now a desideratum, to bring all the diverse forms into one comprehensive view, and allot them their natural places. Most of the genera are in urgent need of revision. Excellent revisions of single groups have already been made by Rousselet, of *Synchæta* (46); Dixon-Nuttall and Freeman, of *Diaschiza* (12); by Jennings, of the Rattulidæ (27); etc. Similar studies of most of the large genera would be a useful preliminary to the preparation of a monograph.

Most authors still continue to recognise, sometimes under protest, the unnatural suborders Loricata and Illoricata, though it would generally be admitted that the possession or lack of a lorica is properly only a specific, or at most a generic or family character. Hudson and Gosse's classification is here followed, with such additions as new discoveries require, and in the Bdelloida a radical redefinition of most of the genera, which, however, can only serve a temporary purpose.

In studying such an extensive group as the Rotifers, few can have the comprehensive knowledge possessed by Rousselet. Most workers will find it desirable to limit themselves to a special study of some smaller group. To such necessary limitation we may ascribe some of the deficiencies of this list. These have been to some extent made good by sending collections and sketches to specialists.

In the preparation of the list I have been greatly assisted by Messrs Bryce and

* About half the known species of *Floscularia* were first discovered by Mr Hood in Scottish lochs, and of this genus alone he has found more species in the lochs than there are Rhizota in this list.

Rousselet, who have at all times been courteously willing to examine drawings and materials sent to them, and to give me the advantage of their judgment as to the value of species. I desire here to express my sense of the obligation they have conferred upon the Lake Survey. The Rotifers recorded for Loch Leven and Loch Gelly were collected by Mr Evans and identified by us.

In common with other groups of lacustrine animals, the Rotifera can be most conveniently studied by treating separately the species inhabiting each region of the lake—the pelagic region, the littoral region, and the abyssal region. The association of species constituting the plankton is very distinct, but of limited number: the littoral region is very rich; the abyssal, if it can be said to exist at all in Scotland, is very thinly populated, and distinguished by negative characters only.

Throughout the text, references to the bibliographical list at the end of the paper are made by figures in heavy type, enclosed in parentheses.

Pelagic Region.

It has been truly remarked by Dr C. Wesenberg Lund (34) that the Rotifera on the whole play but an inconspicuous part in the pelagic region of the larger lakes. The Scottish lakes form no exception to the rule. Nevertheless, the Rotifera must be accorded the second place in importance in the limnetic fauna, as, after the Crustacea, no class of animals except the Rotifera is habitually represented by several species in most, if not all, lakes. The number of species in each lake is small, and, as they are such minute animals, they must become exceedingly numerous before they can be conspicuous in the plankton.

Frequently in the smaller lochs, and perhaps occasionally in the larger ones also, though no instance of it has come under my notice in Scotland, one or more species will so increase as to be for the time being more conspicuous than any other organism in the lake. Species of *Synchæta* and *Asplanchna*, which are giants of their class, most frequently do this. In a little hill loch (L. Breachlaich) near Killin, in the early summer of 1903, *Asplanchna priodonta* was so abundant as to obscure all other life in the loch. After drawing our nets for the usual five minutes, a whitish slime filled the bottom of them, consisting solely of this animal. In a very small loch (Monk Myre) near Blairgowrie, the most truly limnetic of all Rotifers, *Notholca longispina*, coloured the collection (five minutes' tow-netting in a two-ounce bottle) dark red, and little else could be seen.

Sometimes a species, not usually regarded as truly limnetic, will greatly increase for a time in a small loch. In a little loch in Galloway (Loch of Cults), one of the most abundant animals in the plankton was *Polychætus collinsii* (Gosse). This phenomenon might conceivably occur in our great lakes, but has not been observed, and such swarming is probably prevented in them by the always moderate temperature.

The method of collecting the limnetic Rotifera is the simple one of drawing tow-nets

for a definite time through the open water of the lake, as far as convenient from the shore. It is advisable to draw them for a time at some distance below the surface, say 20 feet, as well as at the surface, because in extremes of weather the animals sometimes retire from the layer close to the surface. They should be examined as soon as possible after collecting, as most of them very quickly die under the changed conditions. While some will survive for a time in the bottles, others, such as *Notholca longispina*, are so sensitive to change of temperature that they are seldom found alive when the collections are brought home.

Although very many Rotifera are free-swimming, comparatively few are limnetic, albeit, if the whole world is taken into account, the number is considerable. By limnetic Rotifers is meant such species as normally take up their position, far from the shelter of plants, in the open water of the lake, and extend to every part of it.

Of the truly limnetic Rotifera, few occur together in any one lake; their range may be world-wide, but their distribution is local. A species regarded as limnetic in one part of the world may be only known as an inhabitant of the lake-margins elsewhere. It is well to distinguish, among the limnetic species of one lake or district, between these more or less local species, and the others which belong to that universal association of limnetic animals which are present in all lakes offering normal conditions.

Dr Lund, in the paper above cited (34), gives a short list of species which he characterises as "the cosmopolitan stock of plankton Rotifers." These are *Polyarthra platyptera*, *Synchæta* sp., *Asplanchna priodonta*, *Anuræa cochlearis*, *Anuræa aculeata*, *Notholca longispina*, *Conochilus unicornis*, and *Triarthra longiseta*.

On the whole, Dr Lund's list embodies the species which we find to be most generally distributed in the Scottish lochs. Inasmuch, however, as it is difficult to avoid generalising from partial data, it may be useful if we examine Dr Lund's list in the light of our experience in the Scottish lochs, and indicate some points to which we must take exception.

Scotland is pre-eminently a country of lakes. Considering its situation in a temperate region, the great number of its lakes, many of which, though not of great extent, are from their depth to be classed among great lakes, we would be justified in regarding Scotland as favourable for the existence of the cosmopolitan stock of Rotifers. We would expect to find this stock in all our greater lakes; we would at the least expect that no member of it would be absent or rare. The fact that five out of Dr Lund's eight cosmopolitan species are our commonest limnetic species shows that Scotland is suitable for them. These five most thoroughly limnetic species are *Polyarthra platyptera*, *Asplanchna priodonta*, *Anuræa cochlearis*, *Notholca longispina*, and *Conochilus unicornis*.

Let us now consider the three species which do not live up to their cosmopolitan character in Scotland.

Synchæta sp. is unsatisfactory, as Dr Lund does not name the species which he regards as cosmopolitan. Various species of *Synchæta*, especially *S. pectinata* and

S. tremula, are common in our small lakes; some of the other species may affect more particularly larger lakes; but no one species is general in the lakes, and it is not by any means the case that any *Synchæta* is invariably present. Many lakes have normally no *Synchæta*. I am inclined to regard all the Synchætadæ, like all the Plœsomadæ, as local species.

Triarthra longiseta is more difficult to deal with. It looks a thoroughly limnetic animal; it has a wide distribution in Scotland; and, being more frequently seen in winter and early spring, it may have been overlooked in some lochs, and may be commoner than we know. Still, the fact remains that we have only seen it in some twenty-four lochs, and of these only five are moderately deep, while it is absent from all our greatest lochs. It is less common than *Gastropus stylifer* and *Floscularia pelagica*, which are considered local species. While I am not prepared to trace the universal distribution of the species in lakes, I would point out two facts which confirm our experience of it.

Jennings (26) does not indicate that it is one of the common limnetic species in the Great Lakes, giving only one record, from Sandusky Bay. Zacharias (56) describes a var. *limnetica*, implying that the type is not limnetic; but the variety appears to be rare. The species is found in the plankton lists of many European biologists, but it must be remembered that most of the biological stations are established on shallow lakes.

As to *Anuræa aculeata*, our experience runs quite counter to Dr Lund's. The species has not, to my knowledge, ever occurred in a purely limnetic collection from any lake in Scotland. The type of the species is rare even in littoral collections. Several varieties—*A. serrulata*, *A. brevispina*, and *A. valga*—are of more frequent occurrence among weeds. Of these *A. valga* is most nearly limnetic, being abundant in the plankton of a number of small and shallow lakes; but it also is absent from the larger lakes. As in the case of *Triarthra longiseta*, Jennings' (26) few records indicate that it is not a common lacustrine species in America. As to its presence in the plankton of many European lakes, the same remarks apply as to *Triarthra*.

Besides the five cosmopolitan plankton Rotifers, there have been observed in the Scottish lochs a number of other species, as thoroughly limnetic, but of more local distribution. These are *Floscularia pelagica*, *Floscularia mutabilis*, *Triarthra longiseta*, *Polyarthra euryptera*, *Synchæta pectinata*, *Synchæta tremula*, *Gastropus stylifer*, *Plœsoma hudsoni*, *Plœsoma truncatum*, *Anapus testudo*, and *Conochilus volvox*.

Proales (*Hertwigia*) *parasita*, though not itself limnetic, is carried with its host (*Volvox*) into the open water of many lakes, and some even of our great lakes.

Gastropus stylifer is the commonest of these species. It has been found in about seventy lochs distributed over the whole of the mainland and islands.

Conochilus volvox may be as common, or even more common; but, as it is not so easily recognisable when dead and contracted, we have fewer records for it. It is widely distributed.

Plœsoma, of one species or another, is of general occurrence all over the country, but we were unable to identify the species in so many of the lochs that the distribution cannot be traced. *P. hudsoni* was the commonest species in the islands, but was also found here and there on the mainland, where, however, some smaller species were commoner.

Floscularia pelagica is widely distributed on the mainland, and occurs in Shetland, but was not observed in the Hebrides. Though only recorded from some thirty lochs, it is probably much commoner, as it would readily be overlooked in preserved collections. *Triarthra longiseta* was noted in some twenty-four lochs in Caithness, Sutherland, Ross, Inverness, Edinburgh district, and Galloway. It was not seen in the islands.

We have thus some sixteen species of truly limnetic Rotifers. Many other more or less pelagic species have been found, but they are confined to little lochs or the weedy bays of the larger ones, and cannot with us be called limnetic. A large number of littoral species have occurred casually in the plankton collections, even to such heavy-bodied creepers as *Philodina rugosa* and *P. laticeps*.

Mr Hood, in a recent letter, gives some information as to the seasons when the species of *Plœsoma* are found, and mentions two species which were not identified in any of the Lake Survey collections. The two additional species are *Anarthra aptera*, Hood (19 and 21), and *Plœsoma lenticulare* (18). *Plœsoma hudsoni* he finds from May to August, *P. truncatum* from June to October, *P. lenticulare* from July to September.

Many Continental naturalists give longer lists of plankton Rotifers from limited districts or single lakes than are recorded for the very numerous lakes of Scotland. It is well to bear in mind that most of the biological stations are situated on the shallower lakes, and that the plankton lists include species which are not limnetic in this country.

Dr Lund (32) records twenty-four Rotifers from the plankton of the Danish lakes, ten or twelve of which are littoral species with us. Apstein (1) records twenty-three species from the lakes of Holstein, eight or ten of which are not limnetic in Scotland.

On the other hand, Forel (14) has noted just fifteen species in the great Lake of Geneva ; Stenroos (48), eight in Nurmijärvi-See ; and Jennings (26), twelve species in Lake Erie, all of which are limnetic according to our definition.

The limnetic Rotifers, in common with the other pelagic organisms, extend through all the open waters of the lake, right in to the shore, and frequently occur in the washings of the littoral plants ; they also often occur in ponds. The limnetic region is not characterised by the possession of any species peculiar to itself, but rather by the absence of the majority of the littoral forms, even such as swim freely, and the extension into it of a limited number of species which are especially independent of shelter. The limnetic and the abyssal regions have this in common, that they are in Scotland distinguished by negative rather than positive characters.

How far the limnetic Rotifers extend beneath the surface of the lake is unknown ; we have no data as to the vertical range of the plankton organisms, except for some of the larger Entomostraca.

Littoral Region.

While plankton collections have been made in hundreds of lochs, it has only been possible to examine the littoral region carefully in a few lochs, about twenty-four in number. These are, however, fairly representative, including several of the great lakes, while the smaller ones selected for examination are widely scattered over the whole country from Galloway to Inverness and the Outer Hebrides. It is thus to be hoped that we have obtained a fair idea of the ordinary Rotifer-fauna of our lake-margins.

For the collection of the littoral Rotifers a special method has been devised, which has given satisfactory results. The object is to obtain the Rotifers and other microscopic animals free from débris or larger animals. Water plants of any kind, especially mosses and the finer-leaved flowering plants, are collected along the margin of the lake. They are placed inside a conical net of No. 6 Swiss bolting silk (an ordinary tow-net). This is put inside another net of very fine silk (say No. 17 to 20). The whole is then immersed in the loch with the rims of the nets an inch or two above the surface. The water weeds are then stirred and shaken about and washed in the nets as a bucket, in order to detach the organisms which adhere to them.

The plants are then thrown away, and the coarse net lifted out of the fine one and allowed to drip into it. We then have in the fine net only microscopic organisms and fine sediment. The contents of the coarse net may be examined for worms, Entomostraca, etc.

It has been found by experience that even very large Rotifers will readily pass through the No. 6 net. Possibly giants like *Stephanoceros* would not pass through, but such animals are found by the direct examination of portions of water plants under the microscope.

All water plants will repay examination. Aquatic mosses, such as *Fontinalis* and *Cinclidotus*, semi-aquatic, like *Grimmia apocarpa* and the various species of *Rhacomitrium*, and hepatics will be found to yield the greatest variety. Smooth plants like *Nymphæa*, *Potamogeton*, etc., frequently support numbers of Rhizota, but little else. *Myriophyllum* is sometimes good, especially for Rhizota and Bdelloida. It frequently becomes covered by a slimy growth of diatoms, and is then apparently distasteful to animals, as few or no animals other than Nematodes are found. *Chara*, when free of lime, is fairly productive.

Fontinalis is undoubtedly best of all. The large concave leaves offer just the kind of shelter that Rotifers like, while still it is not too contracted for the many species which enjoy a short swim if it can be taken in safety. *Fontinalis* has never failed to yield a fair harvest, except in the rare case when the lochs get so low that the moss is heated by the sun.

An average collection of littoral Rotifers, made in the manner described above, will contain a large number of species, among which the most prominent genera are likely to be *Euchlanis*, *Cathypna*, *Monostyla*, *Metopidia*, *Colurus*, *Notommata*, *Furcularia*,

Diglena, *Diaschiza*, *Diurella*, *Philodina*, and *Callidina*. These genera constitute the characteristic Rotifer-fauna of lake-margins; other genera, though common enough, are more casual in their occurrence. There are several species of each of these genera common in the littoral region, though none of them are confined to lakes.

It is in the littoral region that the richest Rotifer-fauna is found; in fact, the whole Rotifer population of a lake may be ascertained from the marginal collections, as the limnetic and the abyssal species here meet and mingle with the proper littoral forms. Including the casual as well as the permanent inhabitants, a large number may occur in any one lake. We observed 148 species in Loch Ness—undoubtedly far under the true number—and STENROOS noted 157 in Nurmijärvi-See.

From sixty to eighty of these species may be considered as of ordinary occurrence in lakes, and likely to be found in any lake which is carefully examined. The others are more local and uncertain.

Although by far the most densely peopled part of the lake, the littoral region has not the most marked lacustrine character. It is the few limnetic species which are most truly characteristic of lakes. Although the limnetic Rotifers also occur in ponds, their special characteristics are such as fit them for lake life. These characteristics—spines, transparency, free-swimming, etc.—have probably had their full development in lakes, though the animals now often extend into smaller waters.

The littoral Rotifers are none of them confined to lakes; they may be found in moist places anywhere—in ponds, bogs, streams, and among moss. Nevertheless, even the littoral region has a certain lacustrine character.

Leaving out of account some very shallow lochs and certain bodies of contaminated water near towns, the water of our lochs is, on the whole, pure, if peaty, and the genera given above as most common in lakes are those which have a preference for clear water.

A small number of species may be cited as pre-eminently characteristic of pure lakes, though not exclusively lacustrine. Most of them are Bdelloids. They are *Microdina paradoxa*, *Philodina flaviceps*, *P. brevipes*, *Furcularia reinhardti*, and *Euchlanis lyra*.

The shallow, weedy bays of the larger lochs, such as Inchnacardoch Bay in Loch Ness, afford much the same breeding-grounds for Rotifers as ponds and bogs, and it is in such bays that most of the casual species occur. Here we find swamp Rotifers, Rotifers from streams, and moss-dwellers casually introduced, all flourishing together.

There is one important distinction between such bays and ponds or swamps, which probably accounts for the number of casual species being smaller than might be expected. So long as these bays are in open communication with the deep water of the lake, a moderate temperature is maintained. Inchnacardoch Bay was never more than a trifling degree warmer than the centre of Loch Ness.

The distinction drawn by JENNINGS (26) between swamp and lake Rotifers is as clearly marked here, when such bays become in dry seasons completely cut off from the loch. Such a case is found in an extensive swampy stretch in Burlom Bay, Loch Ness.

When the level of Loch Ness is high this forms a mere bay, having the temperature of the rest of the lake, and all the usual lacustrine animals. In summer it is quite cut off from the loch, becomes greatly heated, and has a stagnant-water fauna distinct from that of the lake.

The littoral Rotifera in Loch Ness had a very distinct winter maximum development. They began to be abundant in December, reached the maximum in February, after which there was a steady and great decline. Many species, notably *Cathypna ligona*, were only seen during the few winter months; others were in the loch all the year round, but increased greatly in numbers in winter. This cycle was traced during two seasons.

Abyssal Region.

As I have already pointed out (40), the limited researches made by the Lake Survey have not revealed in the Scottish lochs any peculiar abyssal organisms whatever, except some Rhizopods which Dr Penard regards as peculiar to great lakes (41, 42). Many Rotifers do, however, extend from the littoral region into what would elsewhere be designated the abyssal region—although that term has no biological significance with us, in the sense in which Forel uses it (14).

Our knowledge of the vertical range of the littoral Rotifers is based on observations in Loch Ness. There alone have our studies been carried on for a sufficiently long time to justify us in supposing that we have a fairly adequate knowledge of the life of the abyssal region. A few species have been got in the mud of other lochs (*i.e.* Loch Rannoch, Loch Oich) at moderate depths. In Loch Ness, dredgings have been made with sufficiently fine nets at all depths down to 700 feet, and often enough to lead us to suppose that if Rotifers were abundant we would have found them. Rotifers were abundant at depths of less than 100 feet. Beyond that depth they became rarer as the depth increased, down to 300 feet, after which they dropped out altogether: only on one occasion was a single species, *Proales daphnicola*, found parasitic upon a worm at 500 feet. Between 250 feet and 300 feet the fine net on several occasions brought up numerous Rotifers, of about twenty species. Dredgings at those depths were unequal, often containing no Rotifers at all. All the Rotifers were of common littoral species. As it is of some interest to know what species are most capable of adapting themselves to varying conditions of light, temperature, pressure, etc., the complete list is given of all the species found at depths exceeding 250 feet:—

Philodina macrostyla, and the form *tuberculata*.
Eosphora najas.
" *digitata*.
Diglena uncinata.
Diurella tenuior.
Diaschiza tenuior.
Euchlanis deflexa.
" *lyra*.
Monostyla lunaris.
Dinocharis tetractis.
Metopidia acuminata.
" *solidus*.
" *triptera*.
" *oxysternum*.
Colurus obtusus.
Proales daphnicola.

Several other species were found which we failed to identify.

The commonest animal in these deeper dredgings was *Diglena uncinata*. The typical form of *Dinocharis tetractis* was rare; but a variety, having the foot-spurs nearly or quite obsolete, was abundant. Several forms of *Eosphora* differed more or less from the types of the two species mentioned.

There is little difficulty in accounting for the presence of these species at such depths. They are all common along the shores of the loch. These shores in many places are very steep, and it is easy to understand how animals which feed among the mud may readily get deeper and deeper. They all feed on organic débris, and such food is brought in abundance to these depths by the rivers, or falls down the steep slopes.

In Loch Rannoch, *Philodina macrostyla* was dredged at a depth of 85 feet, but no Rotifers were found in the greater depths of that loch.

The abyssal region in Loch Ness can only be defined by negative characters; it lacks the majority of the littoral species. The littoral fauna gradually thins out as we descend, till a certain depth is reached, beyond which only a few species survive, and these extend to every part of the lake-bottom. Thus defined, we may say that there are no abyssal Rotifers in Loch Ness, as no species extends all over the bottom, as do *Cyclops gigas*, *Pisidium*, *Candone*, and the rest.

As Dr Penard points out, in dealing with the Rhizopods (42), Scotland has many other lakes, and we may yet discover in some of these the abyssal fauna and the relict fauna of which we have as yet got no trace. Up to the present the indications are against this expectation: north (in Loch Ness) and south (in St Mary's) there is the same abyssal poverty.

LIST OF SPECIES.

Order RHIZOTA.

Family Flosculariadæ.

Floscularia campanulata, Dobie. Loch Ness.
,, *ornata*, Ehr.
,, *pelagica*, Rousselet (43). Widely distributed.
Floscularia mutabilis, Bolton. Loch Morar.
Stephanoceros eichhorni, Ehr. Loch Ness, rare.

Family Melicertadæ.

Œcistes crystallinus, Ehr. Loch Ness.
,, *brachiatus*, Huds. Loch Ness (abundant), Loch Tay.
,, *serpentinus*, Gosse. Loch Ness, one example.
Pseudœcistes rotifer, Stenroos (48). Loch Ness.
Conochilus volvox, Ehr. Generally distributed.
,, *unicornis*, Rousselet. Common everywhere.

Order BDELLOIDA.

Family Microdinadæ.

Microdina paradoxa, Murray (39). Frequent.

Family Philodinadæ.

Philodina :—A. Oviparous, eyes cervical.

Philodina roseola, Ehr. Lochs Morar, Nan Lann, and Duntelchaig.
„ *citrina*, Ehr. Lochs Ness, Nan Lann, Lochy, Morar, Tay, St Mary's, and Kinder.
„ *erythrophthalma*, Ehr. Lochs Ness and Morar.
„ *megalotrocha*, Ehr. Lochs Ness, Uanagan, Tay, Vennachar, An Duin, and Balnagown.
„ *brevipes*, Murray (37). Lochs Ness, Morar, Tay, and Vennachar.
Philodina flaviceps, n. sp., Bryce. Common everywhere.
„ *nemoralis*, Bryce (9). Lochs Ness, Nan Lann, and Killin.
„ *decurvicornis*, Murray (37). Loch Ness, rare.
„ *acuticornis*, Murray (37). Lochs Ness, Killin, Morar, Treig, and Earn.
„ *rugosa*, Bryce (9). Lochs Ness, Morar, Treig, and Earn.

B. Oviparous, eyes absent.

Philodina plena (Bryce) (7). Lochs Morar, Treig, and Earn.
„ *alpium* (Ehr.) (7). Lochs Ness, Lochy, Morar, Tay, and Earn.
„ *brycei* (Weber) (52). Lochs Ness Uanagan, Morar, Treig, and Balnagown.
Philodina humerosa, Murray (39). Lochs Ness and Earn.
„ *hamata*, n. sp. On *Gammarus*, Lochs Tay and St Mary's.
„ *laticeps*, Murray (39). On insect larvæ and *Gammarus*, Lochs Ness, Uanagan, St Mary's, and Skeen.

C. Viviparous, eyes present or absent.

Philodina laticornis, Murray (39). (An exception, really related to *P. laticeps*.) Lochs Ness and Lochy.
„ *macrostyla*, Ehr. Lochs Burraland, Shin, Ness, Uanagan, Morar, Chon, and Kinder; var. *tuberculata* (Gosse), Lochs Rannoch, Ness, and Uanagan.
Philodina aculeata, Ehr. Lochs Ness, Nan Lann, Morar, and Tay.

Callidina :—A. Food moulded into pellets.

Callidina hexodonta (Bergendal) (2). Loch Ness.
„ *rœperi* (Milne) (36). Loch Treig.
„ *elegans*, Ehr.* Lochs Ness and Uanagan.
„ *angusticollis*, Murray (39). Lochs Morar and Ness.
„ *pusilla*, Bryce (6). Loch Morar; var. *textrix* (8), Lochs Ness and Morar (Bryce).
„ *longiceps*, n. sp. Loch Morar.
Callidina leitgebii, Zelinka? (57). Lochs Ness and Earn.
„ *annulata*, Murray (39). Lochs Morar and Earn.
„ *aspera*, Bryce (5). Lochs Ness and Morar.
„ *crenata*, Murray (39). Loch Earn.
„ *lata*, Bryce (5). Lochs Ness, Morar, and Leven.
„ *pulchra*, Murray (39). Loch Ness.

* A mistaken identification, really an undescribed species.

B. Toes three, distinct, no pellets.

Callidina plicata, Bryce (5). Common everywhere.
,, *quadricornifera*, Milne (35). Common everywhere.
,, *habita*, Bryce (7). Lochs Ness, Morar, Gelly (Evans), var. *bullata*, n. var. Murray. Loch Treig.
,, *ehrenbergii*, Janson (24). Lochs Ness, Morar, Tay.
Callidina papillosa, Thompson (49). Lochs Ness, Morar, Tay, Earn, Lomond; Leven and Gelly (Evans).
,, *multispinosa*, Thompson (49). Loch Shin; Loch Gelly (Evans).
,, *aculeata*, Milne (35). Loch Ness.
,, *muricata*, Murray (39). Loch Ness.
,, *crucicornis*, Murray (39). Loch Rannoch.

C. Foot ending in perforate disc.

Callidina symbiotica, Zel. (57). Lochs Ness and Earn.
,, *armata*, Murray (39). Loch Ness.
,, *tetraodon*, Ehr. Lochs Ness, Morar, and Earn.
Callidina russeola, Zel. (58). Lochs Ness and Morar.
,, *magna*, Plate. Loch Ness.

Rotifer.

Rotifer vulgaris, Schrank. Loch Ness, Lochans on Carnahoulin.
,, *neptunius*, Milne (35). Loch Ness.
,, *citrinus*, Ehr. Loch Gelly (Evans).
,, *tardus*, Ehr. Loch Ness.
Rotifer longirostris (Janson) (24). Lochs Morar, Balnagown, Gelly (Evans).
,, *trisecatus*, Weber (51). Loch Ness.
,, *macroceros*, Gosse. Loch Ness.
,, *socialis* (Kellicott). Loch Ness.

Family Adinetadæ.

Adineta vaga, Davis, var. *minor* Bryce. Lochs Ness and Treig; var. *major* Bryce. Lochs Ness, Lochy, Morar, Leven (Evans).
,, *gracilis*, Janson (24). Lochs Ness, Morar, Tay, Earn.
Adineta barbata, Janson (24). Lochs Ness and Earn.
,, *tuberculosa*, Janson (24). Lochs Ness and Earn.

Order PLOÏMA.

Family Microcodidæ.

Microcodon clavus, Ehr. Loch Ness.
Microcodides chlæna, Gosse. Loch Ness.
Microcodides robustus (Glascott) (16), (44). Loch Ness.

Family Asplanchnadæ.

Asplanchna priodonta, Gosse. Everywhere.
Ascomorpha ecaudis, Perty. Loch Ness.

Family Synchætadæ.

Synchæta pectinata, Ehr. Lochs Ghriama, Moine, Chaluim, Bi, Suardalain, Dilate.
Synchæta tremula, Ehr. Lochs Ness, Garbh, Swanney.

Family Triarthradæ.

Polyarthra platyptera, Ehr. Universal.
,, *euryptera* (Wier) (53). Lochs Tingwall, Kilcheran, Black (Argyle), and N. and W. Islands.
Triarthra longiseta, Ehr. Widely distributed. Noted in over 20 lochs; details under Pelagic Rotifera.

Family Hydatinadæ.

Notops hyptopus, Ehr. Loch Ness.

Family Notommatadæ.

Albertia intrusor, Gosse. Loch Ness.
Taphrocampa annulosa, Gosse. Lochs Shin, Ness.
„ *selenura*, Gosse. Loch Ness.
Notommata aurita, Ehr. Loch Ness.
„ *brachyota*, Ehr. Loch Ness.
„ *tripus*, Ehr. Loch Ness.
„ *torulosa*, Duj. Loch Ness (Rousselet).
„ *pumila*, n. sp., Rousselet. Loch Ness.
„ *forcipata*, Gosse. Loch Ness.
Copeus cerberus, Gosse. Loch Ness.
„ *spicatus*, Huds. Loch Morar.
„ *caudatus*, Collins. Loch Ness.
Proales petromyzon, Ehr. Loch Ness.
„ *parasita*, Ehr. Lochs Ness and Magillie, in *Volvox*.
„ *caudata*, Bilfinger. Loch Ness. Identified by Rousselet, from drawing.
„ *sordida*, Gosse. Loch Ness. Identified by Rousselet, from drawing.
„ *daphnicola* (Thompson). Loch Ness, on worm dredged at depth of 500 ft.
Pleurotrocha parasitica, Jennings (26). Loch Ness.
Furcularia longiseta, Ehr. Loch Ness; var. *æqualis* (Ehr.). Loch Morar.
„ *reinhardti*, Ehr. Loch Ness (Rousselet), Lochs Rannoch, Vennachar, Morar, Earn.
„ *forficula*, Ehr. Lochs Earn and Uanagan.
„ *quadrangularis* (Glascott). Lochs Ness and Tay.
Eosphora najas, Ehr. Loch Ness.
„ *digitata*, Ehr. Loch Ness.
Diglena grandis, Gosse. Loch Ness.
„ *forcipata*, Ehr. Lochs Ness, Uanagan, Morar, Tay.
„ *circinator*, Gosse. Loch Ness.
„ *ferox*, Western. Loch Ness. Identified by Rousselet, from drawing.
„ *uncinata*, Milne. Loch Ness.
„ *dromius*, Glascott (16). Loch Ness.

Family Rattulidæ.

Rattulus lophoessus (Gosse). Loch Ness.
„ *longiseta*, Schrank. Lochs Ness, Dochfour, and Dhu.
„ *scipio* (Gosse). Lochs Ness and Meide.
Diurella porcellus (Gosse). Lochs Ness and Earn.
„ *brachyura* (Gosse). Loch Ness.
„ *tenuior* (Gosse). Lochs Ness and Geireann.
„ *tigris*, Müller. Loch Ness.

Family Dinocharidæ.

Dinocharis tetractis, Ehr. Lochs Ness, Morar, Rannoch, Tay, Gulbin, Bhaic, Shin, and Chaluim.
„ *similis*, Stenroos (48). Loch Ness.
„ *pocillum*, Ehr. Lochs Ness and Tay.
Polychætus collinsii, Gosse. Lochs Chaluim, Cults, Morar.
Polychætus subquadratus, Perty. Loch Culag.
Scaridium longicaudatum, Ehr. Lochs Ness and Uanagan.
Stephanops stylatus, Milne (35). Lochs Ness, Morar, Lomond.
„ *tenellus*, Bryce (8). Loch Ness.

Family Salpinadæ.

Diaschiza gibba (Ehr.). Lochs Ness, Tay, Earn, Kinder, Shin, Lochans on Carnahoulin.
„ *tenuior*, Gosse. Loch Ness.
„ *sterea*, Gosse. Loch Morar.
„ *lacinulata* (Müller). Loch Ness.
Diaschiza ventripes, Dixon-Nuttall. Loch Ness.
„ *hoodii*, Gosse. Loch Ness.
„ *tenuiseta*, Burn. Loch Ness, 1 example.
Salpina mucronata, Ehr. Loch Balnagown.
„ *mutica*, Perty. Loch Uanagan.

Family Euchlanidæ.

Euchlanis lyra, Huds. Lochs Ness, Morar, Rannoch, Tay, Earn, Chaluim.
„ *oropha*, Gosse. Lochs Morar, Ness, Tay.
Euchlanis dilatata, Ehr. Lochs Morar, Ness, Tay.
„ *deflexa*, Gosse. Lochs Ness and Earn.
„ *triquetra*, Ehr. Lochs Rannoch, Lyon, Ness.

Family Cathypnadæ.

Cathypna luna, Ehr. Loch Ness.
„ *rusticula*, Gosse. Loch Ness.
„ *ligona*, Dunlop (13). Loch Ness, abundant.
„ *latifrons*, Gosse. Loch Ness.
Distyla flexilis, Gosse. Lochs Rannoch, Ness, Earn.
Distyla depressa, Bryce. Loch Ness.
Monostyla lunaris, Ehr. Lochs Ness, Morar, Tay, Earn, Kinder.
„ *cornuta*, Ehr. Lochs Ness, Uanagan, Morar, Lomond.
„ *bulla*, Gosse. Loch Ness.

Family Coluridæ.

Metopidia lepadella (Ehr.). Lochs Ness, Nan Lann, Uanagan, Ghlas, Earn.
„ *solidus*, Gosse. Lochs Morar, Earn, Ness, Tay.
„ *rhomboides*, Gosse. Lochs Morar, Ness, and Uanagan.
„ *acuminata*, Ehr. Lochs Morar, Tay, Ness, and Chon.
Metopidia triptera, Ehr. Lochs Morar and Ness.
„ *oxysternum*, Gosse. Loch Ness.
Colurus bicuspidatus, Ehr. Lochs Ness, Tay, and Uanagan.
„ *leptus*, Gosse. Lochs Earn and Ness.
„ *obtusus*, Gosse. Lochs Ness and St Mary's.
„ *tesselatus*, Glascott. Lochs Ness and Morar.

Family Pterodinadæ.

Pterodina reflexa, Gosse. Lochs Ness and Kinder.
„ *patina*, Ehr. Loch Duntelchaig.
, *truncata*, Gosse. Loch Ness.
Pterodina cæca, Parsons. On *Asellus*, Loch Ness.
„ *elliptica*, Ehr. Loch Ness.

Family Brachionadæ.

Brachionus pala, Ehr. Lochs Duddingston, Soulseat, Spynie, Lindores.
Noteus quadricornis, Ehr. Loch Fithie.

Family Anuræadæ.

Anuræa cochlearis, Gosse. Universal.
„ *aculeata*, Ehr. Loch Clickhamin.
var. *valga* (Ehr.). Lochs Spynie, Lindores, Herba, Dochard, Harelaw, Balnagown.
var. *serrulata* (Ehr.). Lochs Rannoch, Duntelchaig.
var. *brevispina* (Gosse). Lochs Derclach and Grennoch.
Anuræa hypelasma, Gosse. Lochs in Orkney.
Notholca longispina, Kell. Universal.
„ *foliacea*, Ehr. Lochs Rannoch, Earn, Treig, Awe, Ness, Knockie, Dochard, and Duntelchaig.
„ *striata*, Ehr. Lochs Ness, Iubhair, and Carlingwark.
Eretmia cubeutes, Gosse (?). Lochs Ness and Huna.

Family Plœsomadæ.

Plœsoma truncatum (?) Levander (29). Frequent.
,, *hudsoni*, Imhof. Frequent in N. Uist.
Plœsoma triacanthum (?) Bergendal (3). Lochs Oich and Uanagan.

Family Gastropodidæ.

Gastropus stylifer, Imhof (23). Common, noted in about 70 lochs.

Family Anapodidæ.

Anapus testudo, Lauterborn (28). Lochs Ness, Huna, and Uanagan.

Notes on some of the Species, and Descriptions of New Species.

Melicertadæ.

Melicerta.—Empty houses of species of this genus were found adhering to plants in Lochs Ness and Ruthven, but no living example was seen.

Pseudæcistes rotifer, Stenroos? (Plate V. fig. 18) (48), a gigantic free-swimming Rhizotan found in the shallow water of Inchnacardoch Bay, Loch Ness, is doubtfully referred to this species by Rousselet, who has only seen my rough sketch of it. It has much resemblance to *Æcistes velatus*, Gosse, but is much larger, and has the eyes quite differently situated.

Mr Rousselet informs me that Dr Collins figured and described a form having the eyes near the edge of the corona, and has himself collected such an animal in Dr Collins's favourite pool near Sandhurst. He adds that the eyes are seated on an elevated cushion, a feature shown in my sketch. Our animals were larger than any which Stenroos measured. Total length, 925 μ (Stenroos, 750 μ); length of trunk, 450 μ (Stenroos, 280 μ); diameter of corona, 295 μ (Stenroos, 220 μ). Our measurements were made from free examples, Stenroos's from sessile individuals, and the trunk is therefore more extended and narrower relatively in ours; the measurement of the corona is less in excess of his.

My drawing may be taken as a faithful representation of the general form and proportions, and of the viscera as far as shown. The details of the head were less successfully observed, and I failed to make out the correct orientation of the parts. For these, Stenroos's figure (48) may be consulted. The antennæ were not detected.

Stenroos figures the eyes within the corona; my drawing shows them outside the principal wreath. As Stenroos expressly says that the eyes are deep-seated, the difference may be optical, and due to the point of view. Rousselet says the eyes are on the ventral side.

A very powerful, rapid swimmer, as it rushes across the field with the immense hyaline corona widely expanded, it is one of the most magnificent of Rotifers.

Bdelloida.

Structure.—The details of structure given in a previous paper (39) may be here supplemented from later observations.

Rostral processes.—The rostrum of Bdelloids bears generally, and perhaps invariably, at least four different kinds of processes—the *lamellæ*, the *brush* of cilia, *straight setæ* radiating from the tip close under the lamellæ, and some thicker *tactile setæ* which arise singly or in pairs from about the centre of the base of each lamella.

Most authors only mention the lamellæ and cilia, without discriminating the various kinds of cilia or setæ. Janson (24) states that towards the ventral side the cilia are elongated into 'Tastcilien'; Bryce (7) distinguishes between tactile and motile cilia, without entering into details; Weber (52) only mentions the tuft of cilia, but he figures in *Rotifer vulgaris* two kinds of cilia—at each side a pencil of much longer cilia which probably correspond to the *tactile setæ*. Zacharias most clearly discriminates (55) the crown or tuft of cilia and the two long 'Tasthaare.' The straight radiating setæ I do not find anywhere distinctly referred to. Most figures only show one kind of cilia, which may be the tuft or brush, but in many cases probably indicate the radiating setæ.

Rostral lamellæ.—There is a consensus of opinion among authors, including such excellent observers as Zelinka, Janson, Weber, and Bryce, that the rostral lamellæ are two distinct plates, which in those species where they appear to form a single two-lobed hood are really overlapping at the bases. In deference to these authorities I refer to them as lamellæ, although in many cases they seem to me to form a single organ. In microscopical matters it is especially necessary to avoid the bias of authority, and to describe things as they appear to us, as Zacharias pleads (55) when giving an unorthodox interpretation of the vibratile tags. I have never detected this overlapping of the lamellæ. In many species—*Callidina russeola*, *C. tetraodon*, and *C. plicata* for common examples—the lamellæ appear quite distinct and far apart. In most species studied by me they seem to form a single, more or less distinctly two-lobed hood. The meeting-point of the two lobes generally forms a prominent beak, pointing forwards. In the viviparous Philodinadæ (*P. macrostyla*, etc., and the genus *Rotifer*), the appearance gives some support to a suggestion made by Mr Bryce in a letter, that they are adnate (see Plate V. fig. 21).

In a great many instances, when the lamellæ are most fully extended, the two-lobed character disappears, and the organ appears as a simple hood, like that of *Metopidia*, *Stephanops*, or *Diglena*, merely curved forward at the tip (Plate II. fig. 8*g*).

The *brush*, or *tuft* or *crown* of cilia.—Most conspicuous of the rostral cilia is usually the tuft. These cover most of the surface of the evertile tip, and are usually gathered together into a compact brush, which possesses an automatic motion similar to that of the wreaths, but less regular as to direction. By means of them many species can glide forward rapidly, thus supplementing the Bdelloid step. They probably also assist the wreaths, as they are often in active motion when the animal is feeding,

perhaps giving direction to the weak currents setting towards the discs. Sometimes a few of the cilia act alone in a less automatic fashion.

The *straight setæ* have not been referred to by any writer with whom I am acquainted. They (see figs. 2*a*, 2*b*, and 3) are generally present in the central group of the genus *Philodina*, and they have been seen in many *Callidinæ*. They may be always present, but, if shorter than the lamellæ, would be difficult to see. They vary greatly in length, are conspicuous in *P. rugosa* and *P. acuticornis* (fig. 3), and reach the maximum yet observed in *P. brevipes* (figs. 2*a*, 2*b*). Their function may be supposed to be the same as that of other motionless rigid setæ, such as the whiskers of the cat.

The *tactile setæ* are somewhat flagelliform, tapering and undulate, but thicker than true flagellæ. They vary much in length and thickness, but are always considerably thicker than any other setæ on the rostrum. In some species they are unmistakably paired; in others where they are very small it is uncertain whether there are one or two on each side of the tip. Their motions sometimes appear automatic, but often they seem to be under intelligent control. In *P. macrostyla* and the related species, *P. aculeata* and *P. spinosa*, these setæ are the longest I have seen. In the act of extending the rostrum, these species often put out first the four long setæ as feelers. They undulate slowly, are separated and brought together again, and the animal appears to be feeling if it is safe to come out (fig. 21). These setæ have been seen in the above-mentioned and many other *Philodinæ*, in all species of *Rotifer* where they have been looked for, and in a number of *Callidinæ*. Zacharias (55) figures them of great length, on the ventral side of the brush in *Rotifer vulgaris*; but they appear to be dorsal in the species I have examined.

Central setæ on discs.—The central seta on the disc of a Philodine, or it may be a pencil of very fine setæ, is a familiar structure. The seta usually rises from a papilla, which may be of large size. Central setæ were known in several *Callidinæ*, but they were supposed to be absent from most species of this genus, from all species of the genus *Rotifer*, and from one section of *Philodina*.

Recently I found that *Rotifer socialis* (*Callidina socialis*, Kellicott, which I transfer to the genus *Rotifer*) had in place of the central seta a cluster of short motile cilia (fig. 15*a*). This led me to expect that some modification of the central seta would be found in other species of *Rotifer*, and perhaps throughout the whole of the family Philodinadæ. On *R. tardus* there has been detected a single curved seta, of extreme tenuity, apparently motionless (fig. 22). A large variety of *R. vulgaris*, found in Loch Tay, had shorter setæ which were in active motion. Two curved lines marked the limits of motion in each direction, as we often see in *Vorticella*, etc. (fig. 23). *R. citrinus* has similar setæ.

The papilla from which the central seta springs is generally small; it may be entirely absent; or the greater part of the summit of the disc may be produced into a conical base for the seta (*P. alpium*, etc.).

A peculiar papilla has been seen as yet only in two species, *Philodina laticeps* and *Callidina magna* (fig. 6). It is a large, elevated, gently tapering, conical peg, truncate or slightly expanded at the tip, and bearing there a number of very short motile cilia.

Perforated spurs.—It has been asserted by various authors (Zelinka, Janson, etc.) that the spurs of certain species (*Callidina russeola*, *C. vorax*, *C. parasitica*, etc.) are perforate at the tips, and that ducts convey mucus from the foot-glands to these pores. I have never been able to satisfy myself that any species which I have studied had habitually mucus ducts to the perforate spurs. In two instances, however, have I seen mucus exuding from the tips of the spurs. One example of *Callidina scarlatina* and one of *Philodina acuticornis* (figs. 5, 9*d*) had the mucus forming a thick deposit round the tip of each spur, and gradually tapering to a drawn-out thread, which made the spurs appear longer than they really were. The deposit round the two spurs was too symmetrical to be attributed to accidental contact with the mucus of the toes.

Microdinadæ.

Systematic position.—The relation of the various families of Rotifera to one another is very puzzling. One group of characters would lead us to associate certain families; other groups would lead to different combinations. The discovery of aberrant animals generally assists in the elucidation of affinities, though they often destroy the symmetry of our classifications. Does *Microdina* help us to understand the affinities of the Bdelloids?

The jaws, which I suggested (39) were a kind of link between the Bdelloida and the Melicertadæ, really lead almost as directly to many families of Ploïma, and even to the Scirtopoda.

The Microdinadæ and Seisonidæ may be profitably compared. Both are true Digonata, though this is not brought out in my original figures of *Microdina* (39). The relationship of the Bdelloids and Seisonidæ is perhaps best shown in Lund's classification (31), where he makes them orders of Digonata; but *Microdina* somewhat diminishes the distance between them. *Seison* approaches the Bdelloids not only in the Digonate character, but in the telescopic neck and foot, while the two tufts of setæ recall the wheels of the Bdelloid corona. *Microdina* approaches the Seisonidæ in the shortened gullet, reduced corona (*Paraseison*), and jaws departing from the ramate type. *Seison* has jaws quite remote from the ramate, and more resembling some of the Notommatadæ, and most conspicuously differs from *Microdina* in the union of gullet and œsophagus.

Seison is highly specialised, in adaptation to a peculiar situation and mode of life. *Microdina* does not occupy a peculiar situation; it leads a free life, in company with many other Bdelloids, on mosses and other aquatic plants. It merely gets its living in another manner, and is modified accordingly. The lack of discs and the very strong

toes seem to me adaptive characters. As it feeds by biting, it does not need discs; and as it has not discs, and therefore cannot swim, it would be under a disadvantage without powerful toes.

The close correspondence to the Philodinoid type of structure in almost all but the corona and jaws, especially in the rostrum and foot, suggests that the peculiarities of *Microdina* are due to retrogression from *Philodina*. On the other hand, the transition from a fully developed Philodine to *Microdina* is difficult to imagine, because the short gullet and protrusible jaws must be completely acquired before they would be serviceable.

Since the jaws approximate to the central type of the whole class (see Gosse on the manducatory organs (17)), and the short gullet and protrusible jaws are also frequent throughout the Ploïma, there is some ground for supposing that the Philodinoid corona never has been developed, and that the mouth and jaws are more primitive characters surviving from a common Bdelloid ancestry, from which the Microdinadæ are an earlier branch than the Adinetadæ.

Such conclusions are little more than conjectures, and the discovery of other links may prove that the affinities are quite other than I have supposed.

Microdina paradoxa, Murray.* (Plate IV. fig. 17.)

Since the species was described (39), it has been found frequently in lochs and streams. It has thus been possible to learn more about its structure and habits.

The characteristic red mass in the head has been definitely ascertained to surround the œsophagus. Small examples, which I take to be young, lack this red mass, and are colourless throughout.

The very short gullet was early pointed out as an important character by Mr Bryce (to whom I am greatly indebted for assistance in elucidating the structure of this anomalous animal). The meaning of the short gullet is now understood. The jaws can be completely protruded, as is done by many predatory Notommatadæ, etc. The jaws are not merely snapped and withdrawn. It has been seen to seize a filament of *Spirogyra*, and leisurely chew it for a long time, the jaws all the while half out of the mouth.

Philodinadæ.

The three genera of this family which occur in the lochs are redefined to permit of a more natural arrangement of the numerous species. The eye-spot is given up as a generic character. The character of the toes is the most important feature used in the classification; the mode of reproduction is made use of, for want of anything better. Whatever objection there may be to using the mode of reproduction, unquestionably it characterises natural groups in the Bdelloids.

* Recently collected by Prof. Forel in the Lake of Geneva, the first record, to my knowledge, outside of Scotland.

Philodina.—Toes four. There may or may not be eye-spots; when present, they are cervical. The genus is divided into three sections, denoted by the letters A, B, C. The first two are only for convenience; the third is natural (except *P. laticornis*), and should perhaps form a separate genus.

A. Oviparous, eyes cervical.
B. Oviparous, eyes absent.
C. Viviparous, eyes present or absent.

P. brevipes, Murray. (Plate I. figs. 2*a* to 2*c*.)

Though occasionally locally abundant, the species is uncertain in its occurrence. Its abundance in Loch Morar in 1903–4 enabled me to study it more fully than when the animal was first described (39), and better drawings were obtained, which are here reproduced.

The straight setæ on the rostrum are of extraordinary length, projecting at each side considerably beyond the sides of the head. There are thick tactile setæ under each lamella (fig. 2*b*); it is uncertain whether there is a pair at each side, as there is in *P. macrostyla*.

Seven pairs of vibratile tags were seen—at each side two in the head, on each branch of the forked canal, one pair in the first cervical segment, and four pairs in the central segments. They are set at equal distances apart, but there is a gap in the series, or a wider interval, at the level of the mastax, or between the third and fourth tag at each side, counting from the front. This hiatus appeared in several individuals studied, so I hardly think the tags (which are conspicuous) have been overlooked.

The foot is three-jointed, but there is often an appearance of four joints. In fig. 2*c* I show how this is brought about. Each telescopic segment of the foot of a Bdelloid consists of a somewhat firm cylinder. These are joined together by soft, flexible skin, which renders the telescoping possible. Where the soft skin joins the firmer cylinder there is often a little elevated ridge, more marked than usual in the present species. In the fullest extension of the foot this soft skin, with its limiting ridge, appears like an extra joint.

In Loch Morar, in 1903, all the examples found had a hair-like growth on the head. Mr Bryce considers this hair as fungoid, and attributes to such a growth the *P. hirsuta* of various authors. It is difficult to understand the symmetry of the hair, and its confinement to the head. In *P. laticeps*, similarly affected, the growth was confined to the trunk.

Differing from *P. citrina* in many points, careful study is necessary to discriminate the two species. Less massive than *P. citrina*, *P. brevipes* is also of quick, restless habits, very different from the elephantine deliberation of its relative. The marked characters of rostrum and foot are often difficult to observe. The number of teeth is not a safe character, as *P. brevipes* has the usual $2+1/1+2$, with the third tooth not infrequently as thick as the others.

P. flaviceps, n. sp., Bryce. (Plate I. figs. 1*a* to 1*f*.)

See description further on.

One of the commonest Bdelloids in Scotland, in lochs, streams, bogs, etc. Too common in lochs to call for details of distribution. Ubiquitous though it is, it yet evinces a preference for pure waters.*

The spurs are somewhat variable. In fig. 1*f* I have shown the typical short, blunt spurs; in fig. 1*d*, a longer, straighter pair; in fig. 1*e*, a peculiar form often found in animals otherwise typical; they are placed close together, incurved, acute.

An abnormal example, with flame-shaped 'ligule' between the discs, was found in Loch Ness.

P. rugosa, Bryce (9).

Extremely variable; the type has dental formula 3/3, and red eyes. A variety in Loch Morar had no eyes, teeth 2/2, and a boss on the first foot-segment, as in many *Callidinæ*.

P. acuticornis, Murray (37). (Figs. 3 and 9*a* to 9*d*.)

Occasionally found in lakes, though more at home in bogs and ponds. The original figure being somewhat poor, better drawings since obtained are here given (figs. 9*a*, 9*b*). In dorsal view a graceful animal, the light corona, thin neck, and slender foot tapering to the narrow, acute spurs all impart an appearance of lightness. This appearance is deceptive. In lateral view (fig. 9*b*) it is seen that it has none of the dorso-ventral flattening which is usual in Bdelloids. The central part of the trunk is very deep from front to back—in fact, quite barrel-shaped. This bulk of paunch is necessitated by the very voluminous stomach. The head and foot are really light. In keeping with its heavy trunk, the gait is slow and deliberate. The transverse ventral folds between the segments are distinct and equidistant, as the animal takes the forward step.

P. laticeps, Murray (39).

Though discovered on insect larvæ, this is now known to be the commonest parasite on *Gammarus* in Scotland. This led to a suspicion that it might be identical with Giglioli's *Callidina parasitica*, which he found so common on *Gammarus*. Giglioli (15) says the corona is small, and figures it as extremely small. It is true that the measurement he gives for a small example makes it very large, but there are contradictions in his other measurements; so we are justified in concluding that a deliberate statement, and still more deliberate drawing, are conclusive.

The most obvious distinctive character of *P. laticeps* is the great spreading corona. The pointed end of the last foot-joint of *C. parasitica* is unlike anything in *P. laticeps*. The antenna (calcar) is said to be large and well developed. These terms are relative,

* While these notes are in press, *P. flaviceps* has been found in abundance among moss collected by Prof. Forel in the Lake of Geneva.

but Giglioli's figure shows it prominent at the side, which could hardly be the case with the short, turgid antenna of *P. laticeps*.

Giglioli makes some remarkable statements, which may well seem erroneous, as when he describes a ventral proboscis, at the end of which is the mouth, making no mention of the usual dorsal rostrum—this proboscis, with the mouth, being retracted when the animal is feeding; still, his account is so circumstantial that we must expect *C. parasitica* to have some correspondence with his detailed descriptions and figures. If it were *P. laticeps* which he studied, then it could never be identified from his description, and would have to stand as insufficiently described.

There is no reason to suppose this. *Gammarus* has many other parasites, and new ones are still coming to light. One, *P. hamata*, is here described; another is presently under study. The commonest parasite in one locality may not be the commonest in another. *P. commensalis*, one of those found near London, has never appeared on any *Gammarus* collected by us.*

P. hamata, n. sp. (Plate II. figs. 7*a* to 7*i*.)

Specific characters.—Large, slender; trunk narrow, lacking conspicuous enlargement of central portion; corona very large, much exceeding collar; pedicels long; discs large, oval, thin, saucer-like; antenna long, equalling diameter of neck; rostrum narrow; no eyes; jaws small, teeth 2/2; foot long, of five joints, scarcely tapering from anus to spurs; spurs large, very broad and meeting at base, quickly tapering to acute points, strongly outcurved, so that points on line with base, very strongly decurved; toes four, basal pair small, enclosed in a common basal sheath, close to spurs; ventral pair long, divergent, three-jointed; a fold of skin round bases of spurs on dorsal side. Oviparous.

On *Fontinalis* growing in the river Lochay, near to its junction with the river Dochart, in abundance, November 1905.

When the *Fontinalis* was washed, a great many *Gammarus* were found, and the Rotifer was also abundant, but it was not seen on the *Gammarus*. The appearance of the animal has many points of correspondence with the *Gammarus* and *Asellus* parasites. These are for the most part of large size, with lanky, narrow bodies, long foot, powerful spurs, large corona, and no eyes. In all these respects *P. hamata* looks like a parasite. In a second washing of *Fontinalis* from the same place only a few *Gammari* appeared, and few of the Rotifers. On a third occasion no *Gammarus* was found, and only one *Philodina*.

P. hamata has a close general resemblance to *P. laticeps*. The discs are of the same form, like thin elliptical saucers, and almost as large. They have not, however, the peculiar process characteristic of that species. Other points of difference are the longer and narrower rostrum and antenna, more numerous foot-joints, different form of spurs, with no interstice, and ridge of skin where the spurs join the segment.

* Mr Bryce thinks this has never been found on *Gammarus* anywhere.

The spurs are very strongly curved. In lateral view they look like a drag-anchor; in dorsal view the points are often further forward than the base. They are very slightly movable, and these positions are maintained. The toes are of quite unusual structure. Close under the spurs there projects from the back of the terminal foot-segment a short cylindrical joint; from this issue two short, curved, pointed toes looking like a second pair of spurs; the segment then forks and bears the very large terminal toes. As was the case with the related *P. laticornis* (39), the toes are seldom retracted, but remain extended after the new grip has been taken.

The species has now been definitely ascertained to be parasitic on *Gammarus*, both in Loch Tay and in St Mary's Loch.

It has been sufficiently distinguished from *P. laticeps* above. The remarks made under *P. laticeps* about *Callidina parasitica*, Giglioli, serve to distinguish *P. hamata* also from that species. The lack of eyes, besides other characters, separates it from *P. laticornis* and *P. commensalis*. No other species known to me comes near enough to need detailed comparison.

Callidina.—Oviparous; toes three, or united to form a sucker. This genus also is divided into three sections, indicated by the letters A, B, C. The first is a very natural group, the other two are not so certainly distinct; the symbiotic foot may have been independently acquired by diverse animals, and Zelinka's various symbiotic species do not seem to be particularly closely related otherwise.

A. Food moulded into pellets.
B. Toes three, distinct, no pellets.
C. Toes united to form a sucker.

These subdivisions are rendered necessary by the diverse structure of the numerous species. Group A, the pellet-makers, is one of the largest natural groups within the order, many species being still undescribed.

Although all conform to a uniform type of structure, there is great diversity of external form, the most aberrant being probably *C. cornigera*, *C. rœperi*, and *C. hexodonta*.

These last two are the only species of the genus *Callidina*, as here defined, which possess eyes. As these are placed as in the genera *Rotifer* and *Philodina* respectively, this may be an indication that the group of the pellet-makers is of more than generic value.

In Mr Bryce's projected revision of the classification of the Bdelloids, I understand that the three subdivisions of the genus *Callidina* here adopted will be among the groups elevated to generic rank.

C. hexodonta (Bergendal) (2). (Plate III. fig. 13.)

Mr Bryce has suggested, very plausibly, that this may be *Philodina collaris* of Ehrenberg. As there is some doubt about it, while it is pretty certainly the *Philodina*

hexodonta of BERGENDAL, I retain the latter's specific name in the meantime. Very common in bog-pools, casual in lakes; rarely seen to feed. On one occasion when many were found readily feeding, some details of the head were got (fig. 13). The corona is fairly large for a pellet-maker, rather less than the collar but greater than the neck in diameter. The discs stand some distance apart, and the space between is occupied by a conical ligule. The ligule in Bdelloids is of very uncertain stability, often appearing as a sport in species where no ligule is normally present, and is therefore an unsafe specific character. All the examples of *C. hexodonta* examined possessed one. The very long antenna is kept out when feeding.

C. pusilla, BRYCE (6). (Plate III. figs. 12*a* to 12*c*.)

The type of this species, having a meagre case, has rarely occurred in our collections. The var. *textrix* is frequent. This has a very bulky case, composed of many concentric layers of gelatinous matter. I find two forms which make such cases, and consider them as specifically distinct. One, with a very prominent spout-like lower lip, is here figured (figs. 12*a* to 12*c*). The other, in which the lower lip is not at all prominent, has not been fully studied. The form figured has very prominent rostral lamellæ, a short, thick antenna with very long setæ, and the upper lip terminating in the median line in a projecting ligule-like process. It readily leaves its case and wanders for some time unprotected.

C. longiceps, n. sp. (Plate III. figs. 11*a* to 11*c*).

Specific characters.—Small, with oval trunk, longitudinally plicate; neck narrow, of moderate length; head much elongated; corona slightly wider than the collar, upper lip very extensive; basal segment of rostrum greatly laterally compressed, terminal segment fairly long, terminating when fully extended in a very low cone (the everted tip) covered with short cilia and with no trace of rostral lamellæ. Antenna equal to half the diameter of the neck. Teeth 5/5. Food moulded into pellets. Flame-cells spindle-shaped; three pairs seen. Inhabits a firm, membranous, dirty-yellow case, to which much extraneous matter adheres.

Many Bdelloids inhabit houses of some sort for protection. In *Rotifer macroceros* and some other species the house is little more than an untidy accumulation of débris, collected by the discs in the process of feeding. Others secrete firm membranous cases from the skin of the trunk, and these have a definite form determined by that of the body. Others, again, adopt the cast-off shells of other animals, or joints of the limbs of arthropods, or even vegetable structures. *Callidina annulata*, *C. scarlatina*, and the other so-called symbiotic species adopt a ready-made shelter. Cases of definite form are most commonly secreted by *Callidinæ* of the pellet-making section—among others, by *C. eremita*, *C. angusticollis*, and *C. pusilla*, var. *textrix*. To which class the present

animal belongs is not quite certain. The case does not fit the body very closely, yet does not resemble any other definite organic structure known to me.

Total length when feeding, 277 to 312 μ; length of head from corona to first neck-segment, 77 μ; diameter of corona, 40 μ; length of jaws, 33 μ; of vibratile tags, 12μ. Pellets variable in size, some elongate, and up to 18 μ long. The pellets, after voiding, were cleared out of the case in the same deliberate way I have described (39) in the case of *C. angusticollis*. The rump is slightly marked off from the central trunk, but under the strongest pressure no trace of foot could be seen. I do not doubt that it exists, however, as there is often difficulty in getting a hermit-species to display the foot. The five teeth are unusually strong for a pellet-maker, and there are besides the usual striæ. The peculiar form of the extensive area (upper lip) between the rostrum and the pedicels will be better understood, and the mode in which it joins with the rostral base better seen, from the figures than from any description.

In the half-extended rostrum two rounded lobes suggest the lamellæ; but when the tip is most fully everted there is no trace of lamellæ, though they were very carefully looked for. No processes were seen on the low conical tip except very fine setæ of uniform length, which covered it all over. No central setæ were seen on the discs.

Habitat.—On aquatic mosses from the islands in Loch Morar, 5th March 1905.

C. aspera, Bryce (5). (Plate IV. figs. 16*a* to 16*c*.)

Its abundance in Loch Ness and district enabled me to study some points in the structure of this interesting species which I have not seen previously noted. The food is moulded into pellets—a character readily overlooked, owing to the thick papillose skin. The large discs are close together, and strongly inclined forward. The apparent motion of the cilia passes uninterruptedly round both discs, as though they were one, as is also seen in *C. annulatus*, *Œcistes*, etc. The upper lip terminates in a median conical process, which looks like a 'ligule,' though really of another nature. A similar process is seen in *C. pusilla* (fig. 12*b*).

C. crenata, Murray. (Plate I. fig. 4.)

When described (39), the animal had not been seen feeding. This has now been done, and the corona is figured. The head is relatively very small, and the corona less than the collar.

C. habita, Bryce (7).

Apparently a variable animal, but there is a suspicion that several similar species have been confused together. A remarkable variety, probably of specific rank, is described below.

Lochs Ness, Morar, Treig, Gelly (Evans).

Var. *bullata*, n. var. (Plate III. figs. 10*a* to 10*d*.)

Distinctive characters.—Less robust than the type, head and foot more elongate, colour yellowish. First joint of foot with eight prominences, in three rows: first row, nearest base, of four equal hemispherical processes, two lateral, two dorsal; second row, of two lateral processes, like those of the first row, and one median dorsal, transversely elongate, as though formed by the junction of two hemispherical processes; third, a single very prominent median process.

The very ornate foot is the most important character of the variety, but the narrower form, longer extremities, and yellowish colour all further distinguish it from the type. A few examples were sent to Mr Bryce, who succeeded in finding them, and after some study suggested that the form belonged to *C. habita*. In deference to his opinion, I subordinate it to that species as a variety.

Among submerged moss on rocks at the margin of Loch Treig, December 1904, abundant. Recently found also in India.

Rotifer.—Viviparous, toes three, eyes present or absent. When eyes are present they are in the rostrum. All the species in this list possess eyes, except *R. longirostris* (Janson) and *R. socialis* (Kellicott).

R. neptunius, Milne (35).

This is closely related to *R. trisecatus* (51), which it nearly equals in length, but is narrower. I can only see two joints in the long spurs; in *R. trisecatus* there are three. The ventral toes are of extraordinary length, when fully extended even exceeding the spurs, but appear to be only two-jointed. The median dorsal toe appears shorter; if it be as long as the others, it is habitually less extended. The teeth on the jaws are of only moderate thickness.

R. trisecatus, Weber (51). (Plate V. figs. 20*a* to 20*c*.)

This gigantic Bdelloid was only once seen in a loch, but is known in ponds (38, 47). The foot is short for the genus, but of the usual five segments. The very large spurs are distinctly three-jointed (fig. 20*c*). I have never seen it feeding, so as to observe the characters of the corona. A very good distinctive mark of the species is offered by the teeth (fig. 20*a*), which are of very unusual breadth. These are better shown in Weber's original figure (51, Plate XXX.) than in his later work (52, Plate 14).

R. socialis (Kellicott). (Plate IV. figs. 15*a* to 15*e*.)

The commonest of the parasites on *Asellus*. An extremely long animal, and ungainly when creeping, it assumes the form of an elegant vase when feeding. The very

long foot has one segment more than is usual in the genus. The large figure (15*a*) on Plate IV. shows the foot partly retracted; the smaller figure (15*b*) shows the true proportions. The corona is of the form usual in the genus. The discs bear each a central tuft of motile cilia, corresponding to the central setæ of *Philodina*, etc. The collar is more worthy of the name than usual, consisting of a long pendant flap, very broad in the lateral part. Intestine pear-shaped. Reproduction viviparous. Loch Ness and the Caledonian Canal.

Adinetadæ.

A. tuberculosa, Janson (24). (Plate IV. fig. 14.)

This species has been found among hepatics at the margins of one or two lochs, and in other situations. The most distinctive character of the species is the series of coarse papillæ which cover part of the body.

All the Scottish examples differ from Janson's description in one important particular. Janson says that the tubercles cover the whole body, with the exception of the last foot-segment. All the examples I have seen have no tubercles on the central segments of the trunk. On the adjacent neck-segment and preanal the papillæ are largest, and diminish in size forwards and backwards from these segments, but remain large in several rows in the middle of the head. Their absence from the central segments is the more remarkable, as, in most species possessing a similar armature, this is confined to these very segments, or is strongest there and diminishes or disappears on the neck and foot.

The spurs also differ from those figured by Janson, which are simply tapering, acuminate and acute. In our specimens they are enlarged from the base upwards for about two-thirds of their length, then shortly acuminate.

Margins of Lochs Ness and Earn.

Notommatadæ.

Albertia intrusor, Gosse. (Plate V. figs. 24*a* to 24*d*.)

In every example of *Stylaria lacustris* which I have examined under pressure, one or more parasites of the genus *Albertia* were invariably present. The species comes so near *A. intrusor*, Gosse—although Gosse's figure gives no idea of the great posterior enlargement—that I identify my animal with that species.

In situ in the gut of the worm they were readily detected by their motions, alternately extending and contracting. When set free by the death of the host their behaviour was remarkable. They crept along in Bdelloid fashion, although no hold appeared to be taken by the toes. The head-grip was loosened, the posterior part of the body apparently

retaining its position by its superior weight till a new grip was taken by the mouth. The remarkable feature was that they walked backward, and at each step the anal region was greatly expanded, being then by far the widest part of the body, perhaps twice the diameter of the middle of the trunk. In this action the short foot became quite lateral. The individuals behaving in this way carried eggs, and I interpret the action as an attempt to lay the eggs as the fear of death came upon them after the death of the host. When first the species was observed, this action was going on; the small jaws had not been seen, and the mode of creeping gave the impression that the broad end was anterior, and the expanded anus a great sucker with which the animal was seeking for a fresh hold. The true relation of parts soon became apparent.

Proales daphnicola (Thompson) (50). (Plate VI., figs. 26*a* to 26*e*.)

Mr Rousselet identifies as this species an animal of which I sent him a drawing, although there are some little discrepancies.

If it is this species, the situation in which it was found is remarkable. It was dredged at a depth of 500 feet in the middle of Loch Ness, and it was parasitic, not upon a Daphnid, but upon an oligochæte worm. When examined, the worm was moribund: the Rotifers, though all living when first seen, soon died, and the studies obtained were not so complete as could be desired. The species of worm was not ascertained. It was either a different species from the others taken in the same dredging, or it was in a pathological condition, as it adhered to the glass when placed upon it, which the others did not.

Five individual Rotifers were adhering to the worm, near the extremity. All were in the same position, the very broad head applied to the skin, and the feet all pointing backwards.

This is the greatest depth at which we have obtained a Rotifer, although in Loch Ness many go down to 300 feet.

Pleurotrocha parasitica, Jennings (26).

From a very incomplete drawing, Mr Rousselet suggested this identification. On comparing Jennings' figures, I am satisfied that this is the animal found, adhering to the skin of an Oligochæte, in Loch Ness.

Furcularia longiseta, Ehr., var. *æqualis*, Ehr.

A variety with equal toes was frequent in Loch Morar in 1903. The animal was both smaller and more slender than the type, and the equal toes were almost quite symmetrical.

F. quadrangularis, (Glascott) (16).

In spite of some little discrepancies, Miss Glascott's rough drawing of *Notops quadrangularis* faithfully represents a little animal which is not infrequent in lochs, though never abundant. The patches of brown globules render the identification almost certain. The trunk is very broad, oblong, of firm texture, and maintains its shape. In the Scotch examples the patches of globules have a slightly different arrangement from that shown in Miss Glascott's figure. The two shoulder patches are the same; there is only one posterior patch, which is median and dorsal; there is a less-defined median dorsal patch between the shoulder patches. The eye is smaller and nearer the front; the toes are rather shorter. The foot is telescopic and elbowed, as in *F. reinhardti*, but it performs none of the contortions of that violent species. This is a very unobtrusive, quiet little beast, which goes slowly about, feeding, scarcely altering its form or the position of the foot. From the position of the eyes, the characters of the foot and of the jaws, as far as seen, it seems to me to be a *Furcularia*, and not a *Notops*.

F. reinhardti, Ehr. (? = *Notommata theodora*, Gosse).

Of very common occurrence in Scottish lochs is a narrow, long-footed animal of the genus *Furcularia*. Whether there is only one species of this description is not certain; sometimes it is of moderate size and quiet habits, sometimes very large and extremely active, the general form in both cases the same, and the animals not separable without closer study than we have been able to give. Gosse's description of *Notommata theodora*, its form, glassy transparency, and the mode of moving the immensely long foot, apply perfectly to the larger form. Great numbers of the lesser form are often found, in plankton collections, dead or dying, with a filament of some sort, algoid or fungoid, apparently choking them. The foot is habitually bent downward, as well as from side to side.

Dinocharidæ.

Dinocharis tetractis, Ehr.

This species varies greatly in relative length and breadth. The extreme in one direction is a form frequent in bogs. The trunk is very large, very broad, and the foot relatively small. This occurs in lochs, but is rare. Lacustrine specimens are generally much narrower, the foot and the toes relatively longer, in extreme forms approaching the next species, though always distinguishable by the proportions of the foot-joints. I have already noted, in treating of the abyssal region, the reduction of the foot-spurs in abyssal examples.

D. similis, Stenroos (48).

This species, distinguished by the great elongation of the second foot-joint, was of rare occurrence in Loch Ness, and has not yet been seen in any other loch.

Stephanops tenellus, Bryce. (Plate V. figs. 19*a*, 19*b*.)

Discovered by Bryce in moss from Spitzbergen (8). The extreme activity of the animal baffled its discoverer in his efforts to secure a portrait. At a later date, when it was found in Loch Ness, I was more fortunate, and subsequently, with the aid of narcotics, obtained the drawings here presented.

It is very closely related to *S. stylatus*, Milne (35), of which it is almost an exact miniature. The most important points of difference are, the smaller size, narrower form, narrower and longer jaws, and shorter toes. As Mr Bryce pointed out, under low powers the viscera give the apparent outline of the central parts of the trunk, the hyaline lorica being invisible, and the animal seems more slender than it really is. Both head and lorica are, however, relatively narrower than in *S. stylatus*. In dorsal view the toes are about $\frac{1}{12}$ of the total length, those of *S. stylatus* about $\frac{1}{7}$. Owing to the strong decurvature of the toes of both species, their actual length forms a greater proportion of the whole than these figures indicate.

Length, about $\frac{1}{226}$ inch (110 μ). This is larger than Bryce states ($\frac{1}{300}$ inch), but such a lively animal is not easy to measure. After death accurate measurements cannot be made, as under pressure dead examples elongate in a remarkable degree. *S. stylatus* is nearly twice as long. Many examples contained a well-developed egg. The pair of very long setæ are directed upwards as well as backwards. The number of forward-pointing setæ is uncertain. The strong motile cilia by means of which the animal runs forward are, both in appearance and mode of action, singularly like the 'legs' of *Euplotes charon* and related Ciliata.

Coluridæ.

Colurus tesselatus, Glascott (16). (Plate VI. figs. 27*a*, 27*b*.)

A little facetted *Colurus* found in Loch Morar and Loch Ness belongs, I think, to this species, although it differs greatly in form from Miss Glascott's figures. She shows the lorica, in side view, as triangular, and highest in front; in dorsal view, as greatly expanded at the posterior angles, although broadest in the middle.

The animal, as I know it, agrees with Miss Glascott's description as to the tessellated surface, raised at the sutures. It differs in the following points:—The form is that normal in the genus; in lateral view an evenly rounded back is seen, highest a little in front of the middle, and very little lower at the posterior edge than in front. In dorsal

view it is seen that the sides are flat and parallel in the middle, with sloping portion making about the same angle to the front and back. The posterior sinus is concave, of moderate size, the anterior small. A slight ridge marks the middle of the back. The facets are symmetrically arranged on each side of this; they do not break the median line as shown by Miss GLASCOTT. There are about nine distinct facets on each half of the lorica, and they are in three rows parallel with the median line.

Miss GLASCOTT considers it a rare species, and it is so in Scotland. It has only been found in two lochs in Scotland, Lochs Ness and Morar. Not very abundant when gathered, it increased greatly during a whole winter, in tightly corked bottles.

PLŒSOMADÆ.

The confusion of the synonymy among the species of this family is, I imagine, without parallel among Rotifers. This has now been pretty well sorted out, but while it prevailed it was found difficult to name most of our species, so the distribution in Scotland is not traced.

Plœsoma triacanthum (BERGENDAL) (3). (Plate VI. figs. 28*a*, 28*b*.)

Though I have recorded under this name a three-spined *Plœsoma* found in one or two lochs, there is some doubt as to its being that species. There has since been found in a pond in the same district a smaller animal which agrees more closely with BERGENDAL'S and LEVANDER'S figures. Fig. 28*b* is the animal found in the lochs; fig. 28*a* is the smaller species, probably *P. triacanthum*; both are drawn to the same scale.

ANAPODIDÆ.

Some authors (10, 30), have doubted the specific distinctness of the two alleged species of this genus, and those who admit both, as WEBER (52), agree that they are separated by very minute characters.

Being unable to decide to which species our animal should be assigned, or to find out which of the two names, both of which were bestowed in the same year, has priority, I put it under that which it most resembles.

ANURÆADÆ.

Eretmia cubeutes, GOSSE.

No living *Eretmia* has been seen, but in Loch Ness were found numerous tests, strikingly like Rhizopod shells.* The spines were placed as in *E. cubeutes*, and most of the tests contained the trophi of a Rotifer, in the same definite position.

* Mr ROUSSELET has little doubt these are Rhizopod shells, into which Rotifers have somehow got; but they are quite different from the only Rhizopod (*Euglypha alveolata*), of similar form, known to me.

Notommata pumila, n. sp. By C. F. Rousselet, F.R.M.S.

(Plate VI. figs. 25*a* to 25*c*.)

Specific characters.—Body stout, elongated, plump and rounded dorso-posteriorly; the head remarkably small, less than half the width of the body immediately behind it, tubular, and surmounted by a tuft of vibratile cilia, without auricles or other prominences; small clear brain with small cervical eye on the under surface near its posterior extremity. Foot stout and rounded, carrying two small, pointed, slightly recurved toes, deeply shouldered on the dorsal side of their extremity. Size—length, 127 μ ($\frac{1}{200}$ inch); width, 54 μ ($\frac{1}{470}$ inch); toes, 14 μ ($\frac{1}{1800}$ inch).

Habitat.—Amongst moss in Caledonian Canal near Fort-Augustus, Scotland.

I found this species in November 1904, by washing out damp moss kindly sent to me by Mr James Murray from the Caledonian Canal; but it appears it had previously been observed in January of the same year by this gentleman, and I could readily recognise it from his sketches.

The peculiar formation of the small tubular head gives the animal a striking aspect, which is only shared by Miss Glascott's *Notommata gigantea*, with which it has indeed considerable resemblance; and if it had not been for the peculiar structure of its toes and its diminutive size, I would have been inclined to refer it to that species.

The integument is white, transparent, soft, and yet with a certain amount of stiffness, so as to always maintain the animal's shape. Posteriorly, a broad triangular fold indicates the beginning of a stout, jointless foot, which carries two short recurved toes, of peculiar and characteristic shape, distinctly and deeply shouldered at the extremity; an enlarged figure of the toes is given in fig. 25*c*.

A clear brain of moderate size carries a small red eye on its under side.

The mastax is of large dimensions for the size of the animal, and contains powerful and complex jaws of forcipate type (fig. 25*b*). The manubria in particular consist of two separate chitinous rods on each side, and joined at their extremities. I do not remember a similar structure in any other Rotifer. The unci are broadened plates, apparently without teeth—at least I was unable to detect any. Above the unci were seen some apparently loose and curved chitinous rodlets, which remained in position after dissolving the soft parts with caustic potash. The rami are small, and their exact shape and structure difficult to observe. In fig. 25*b* I have represented what I was able to make out of the incus; the fulcrum is a narrow and short rod, curving inwards and broadening at its base.

Dorsal and lateral antennæ are present in their usual positions. A large stomach and intestine fill the greater part of the body cavity; the other organs are quite normal and call for no detailed description.

Notommata gigantea, with which I have compared this new species, is vastly larger, reaching 726 μ ($\frac{1}{35}$ inch) in length, according to Miss Glascott, has very small toes, which are not shouldered, and the mastax also is small and apparently

contains jaws of a different type. These differences sufficiently separate the two species.

The figure accompanying this description has been drawn by my friend, Mr F. R. Dixon-Nuttall, with his accustomed skill from my mounted specimen.

Philodina flaviceps, n. sp. By David Bryce.

(Plate I. figs. 1*a* to 1*f*.)

Specific characters.—Of medium size (about 320 μ), and only moderately stout. Skin smooth. Corona rather ample (about 70 μ), about one-fourth more than collar. Rami with 2/2 teeth. Foot of four joints, moderately stout. Spurs, short thick cones (about 6 μ long), held nearly parallel, separated by a concave interstice (3 μ wide). Toes four.

This species was very abundant in washing of *Lemanea* (*Sacheria*) gathered in Loch Vennachar in May 1902 by Mr James Murray, and has occurred later in gatherings from other waters sent to me by him from time to time. Its distinctive features are the shortness and thickness of the spurs, the marked concavity of the interstice, and the rather ample expanse of the corona, whose width equals quite one-fifth of the length of the animal. Moderately grown examples might perhaps at first sight be taken for *P. nemoralis*, but attention to these details will sufficiently establish the identity of this species. Most of the examples seen were noticeable for their clear yellow tint, and especially because the colouring was not confined to the trunk, or central portion of the body, but extended over the neck and head as far as the rostrum. This deviation from the general rule has suggested the specific name.

The antenna was of moderate length, and the mastax and other organs were apparently normal.

Although the animal seems to favour a habitat in open waters, specimens confined in a small cell showed themselves fairly hardy, and produced eggs somewhat freely for the first few days. These were approximately oval in outline, inclining to the *Citrina* type, the smaller pole being distinctly less obtusely rounded than the greater, and in one instance rising to a low knob-like prominence. One of these hatched out within seven days after extrusion. I observed that several adults crawling about were constricted at the third cervical segment. In confinement they soon settled down, and thereafter were loth to shift their quarters. Some examples seemed to remain for days together without changing their place. While feeding, the body was in incessant movement, swaying to right and to left, raising itself more or less upright, or lowering itself to a nearly prone position, whilst ever retaining its foothold.

The eggs measured from 65 μ to 70 μ in length, and from 48 μ to 54 μ in width.

Note on the Rotifera of Ponds, as compared with Lakes.

Neither physically nor biologically can any hard and fast line be drawn between lochs and ponds. In making the bathymetrical survey, the practice was to examine any body of water on which a boat was found, or could easily be placed, omitting as a rule those of less than quarter of a mile in greatest diameter.

Some lochans of less than quarter of a mile in length—for example, Lochan Dubh at Lochailort—were of such depth that the temperature and the biological phenomena showed a correspondence with our greatest lakes, rather than with shallow lakes or ponds. On the other hand, some very considerable lochs were so shallow that the temperature had the extreme range found in small ponds, and the biology corresponded.

The foregoing list of Rotifers is restricted to species found in lochs which were bathymetrically surveyed. When practicable, we also examined ponds adjoining the lochs for purposes of comparison, and periodical collections are being made from certain small ponds, in order to compare the annual cycle of changes with that which occurs in lochs. This investigation is still incomplete, and will be dealt with when finished. A full account of the Rotifera of ponds would be too extensive to be included here. At present it is only intended to contrast the relative frequency of the species in our list in lakes and ponds, and to describe a free-swimming Bdelloid which came to light in the course of these researches.

All the Rhizota in the list, except the species of *Conochilus*, *Floscularia pelagica*, and *F. mutabilis*, are commoner in ponds, and are not very commonly found in lakes. Even the powerful swimmer, *Pseudæcistes rotifer*, prefers ponds and ditches. Of the Bdelloida, the various genera are different in their habits. On the whole, the oviparous kinds are more at home in lakes, the viviparous in ponds, but there are exceptions. Most of the species of *Philodina* which we have recorded are very much at home in lakes, and several of them, with the related *Microdina*, are the most characteristic of lake-margin forms. *P. citrina*, *P. acuticornis*, and the two viviparous species are pond-dwellers.

The genus *Rotifer* is on the whole rare in lochs. I have found no species common in lochs except the parasitic *R. socialis*; *R. macroceros* is next in frequency, the others rare.

In ponds adjoining Loch Ness we found *R. vulgaris*, *R. citrinus*, *R. tardus*, *R. longirostris*, *R. macrurus* (which is not in our list as a lake species) all common and abundant. *R. neptunius* is frequent, and *R. trisecatus* not very rare in ponds. *R. macrurus* is most at home in bog-pools, and *R. longirostris* among dirty moss.

Many of the *Callidinæ* are ubiquitous—equally at home in ponds, lochs, and elsewhere. None are particularly characteristic of lake-margins, but *C. muricata*, *C. crucicornis*, and *C. incrassata* (not yet found in lochs) are true pond species.

The pellet-making *Callidinæ*, though well represented in our list, are with few exceptions properly peat-bog species. *C. elegans* (?), *C. pusilla*, and *C. longiceps* are

more adapted for lake or pond life. The others are bog- or moss-dwellers, except *C. annulatus* and *C. aspera*, which are commonly 'symbiotic' with hepatics on trees.

The Adinetadæ on our list are all moss-dwellers, and casual, though frequent, in lochs. *A. oculata*, which is not on the list, is a pond species.

The Ploïma are too numerous to be compared in detail. A large number of the pond species have not yet been seen in lakes, though there is no reason why they should not be expected sooner or later.

The Microcodidæ, active swimmers though they are, are pond species; the Asplanchnadæ, Synchætadæ, and Triarthradæ chiefly lacustrine.

The host of Notommatadæ are about equally divided, some of the species being eminently characteristic of lakes.

The Hydatinadæ and Rattulidæ are most frequent in ponds, the Dinocharidæ in bogs and ponds.

The remaining families of loricated Ploïma are fairly adapted to a lacustrine life, the Pterodinadæ among these being most restricted to ponds. In the Plœsomadæ are both lake and pond species.

Callidina natans, n. sp. (Plate II. figs. 8*a* to 8*i*.)

Specific characters.—Of moderate size, whitish. Free-swimming. When swimming, broadest at corona, tapering to very slender foot, with slight expansion in central part of trunk. Rostrum long, extended forward when swimming; lamellæ apparently united in single large hood, as in *Metopidia* and *Stephanops*; antenna equal to three-fifths diameter of neck, directed backwards. Jaws very long and narrow; teeth 2/2, 2/1, or 3/1, very excentric. Stomach large. Foot very slender, hardly tapering, one-fifth of total length, one-third formed by the terminal segment; spurs minute, acute; toes three, large. Food not moulded into pellets. Trunk closely plicate, in optical section elliptical. No processes seen on rostrum except lamellæ and brush of cilia. Vibratile tags narrow, parallel-sided, 14 μ long; three pairs seen.

Length when swimming, 400 μ; when creeping, scarcely greater. Diameter of corona, 90 μ; of neck, 55 μ; of trunk, 75 μ.

Owing to the habit of stretching the rostrum forward when swimming, the upper lip could not be clearly observed. The discs are large, and only separated by a small space (about quarter the diameter of one disc), across which stretches a hyaline membrane almost on a level with the discs. From time to time, as the animal turned slightly in swimming, a little sharp elevation was seen between the discs. This I regard, not as a 'ligule' proper, which should be an independent structure, but as probably the angle of meeting of the skin-folds so characteristic of the upper lip, and which form a similar angle in other species.

The rostral lamellæ are of rather unusual form. When fully extended they quite lose the appearance of being two-lobed presented by most rostral lamellæ, and look like a hood, gently curved forward at the tip (fig. 8*g*).

The jaws are exceptionally narrow, being only equalled by some of the pellet-makers, the shape being in those cases quite different. In this the outline of the jaw is nearly a perfect arc of a circle.

Central setæ were not observed on the discs.

On such short acquaintance it is impossible to suggest the affinities within the genus. Though no eggs were seen, the absence of fœtus places it in the oviparous, non-pellet-making section of *Callidina*, with *C. plicata*, etc. In appearance it has no close relationship with the other animals in the section.

Habits.—Free-swimming in company with *Brachionus pala* and *Anuræa valga*. When swimming, the rostrum and antenna are kept fully extended, the rostrum projecting in front of the corona, concealing the upper lip. From the broad corona to the toes, the general form is that of an elongate cone, though there is a narrowing at the neck and expansion in the central segments. The foot is also kept fully extended, even to the toes, and trails behind like a tail.

Under the cover-slip it continually tried to swim, but, having too little room, was often compelled to stop. It then wriggled on its side in an aimless fashion. The little foot was drawn into the somewhat heavy trunk and shot out again, curling about like a worm. It seemed to be unfamiliar with the use of the toes for creeping, and some time passed before it made attempts in that direction. Even when it got on its feet, the toes were never drawn into their sheath in the usual way, but kept extended to their full length.

The animal made its appearance in considerable numbers in a pond which dries up in summer, within a week after the pond filled at the beginning of winter. The pond is only a foot or two in depth, but when the collection was made it was calm and clear, and the collection was taken without disturbing the bottom; so there seems little doubt that it is a true swimmer, if only in shallow waters, and its behaviour under the confinement of the cover-slip confirms this.

Habitat.—In a pond which fills each winter, and dries in summer, at Nerston, East Kilbride. Fairly abundant on the day when it was detected, it has never been again found, though the pond has been examined in the same manner at regular intervals ever since. Fortunately, the original collection was sent to Mr Bryce, who found some of the animals, and confirmed my diagnosis in some particulars, while agreeing with me that it was distinct from any species previously seen.

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EXPLANATION OF PLATES.

The figures are all drawn by me from living animals, except that of *Notommata pumila*, which is drawn by Mr F. R. Dixon-Nuttall from a specimen mounted by Mr Rousselet, and the jaws of the same species, which are copied from a sketch by Mr Rousselet. The drawings of the whole animals are as far as possible drawn to the same scale, so that some idea of comparative size may be got. *Pseudœcistes rotifer* was so large that it had to be drawn on a reduced scale.

Plate I.

1. *Philodina flaviceps*, n. sp., Bryce.
   - *a*, dorsal view of whole animal, feeding.
   - *b*, ventral view, creeping.
   - *c*, jaw.
   - *d*, spurs, common variety.
   - *e*, spurs, a rare variety.
   - *f*, spurs and toes, commonest form.
2. *Philodina brevipes*, Murray.
   - *a*, dorsal view, showing whiskers and tags.
   - *b*, rostral tip, with whiskers and motile setæ.
   - *c*, foot, illustrating mode of telescoping.
3. *Philodina acuticornis*, Murray. Rostral tip.
4. *Callidina crenata*, Murray. Head.
5. *Callidina scarlatina*, Ehr. Spurs elongated by mucus.
6. *Callidina magna*, Plate. Head, showing large processes on discs. Wreath omitted.

Plate II.

7. *Philodina hamata*, n. sp.
   - *a*, dorsal view, feeding.
   - *b*, antenna, to same scale as whole animal.
   - *c*, rostral tip, ventral side.
   - *d*, rostral tip, lateral view.
   - *e*, jaw.
   - *f*, spurs, with basal fold, dorsal view.
   - *g*, spurs and toes, from the side.
   - *h*, spurs, another dorsal view.
   - *i*, spurs and toes, ventral side.
8. *Callidina natans*, n. sp.
   - *a*, dorsal view, swimming.
   - *b*, lateral view.
   - *c*, jaws.
   - *d*, optical section of trunk.
   - *e*, spurs, approximated.
   - *f*, spurs, separated.
   - *g*, rostral hood, dorsal view.
   - *h*, rostral tip, from below.
   - *i*, spurs and toes.
9. *Philodina acuticornis*, Murray.
   - *a*, dorsal view, feeding.
   - *b*, lateral view.
   - *c*, normal spurs.
   - *d*, very slender spurs elongated by mucus.

Plate III.

10. *Callidina habita*, var. *bullata*, n. var.
    - *a*, dorsal view.
    - *b*, jaws, mouth and gullet.
    - *c*, dorsal view of foot.
    - *d*, lateral view of foot.
11. *Callidina longiceps*, n. sp.
    - *a*, the animal in its house.
    - *b*, head, more enlarged.
    - *c*, jaw.
12. *Callidina pusilla*, Bryce. Variety.
    - *a*, lateral view, showing prominent lower lip.
    - *b*, head and neck, dorsal view.
    - *c*, head, ventral view.
13. *Callidina hexodonta* (Bergendal). Head.

Plate IV.

14. *Adineta tuberculosa*, Janson.
15. *Rotifer socialis* (Kellicott).
    a, animal with foot partially retracted.
    b, small-scale drawing, to show proportions.
    c, jaw.
    d, antenna.
    e, foot, last three segments, and toes.
16. *Callidina aspera*, Bryce.
    a, dorsal view, feeding.
    b, jaw.
    c, portion of trunk, showing tubercles.
17. *Microdina paradoxa*, Murray, with jaws protruded, biting a filament of Alga.

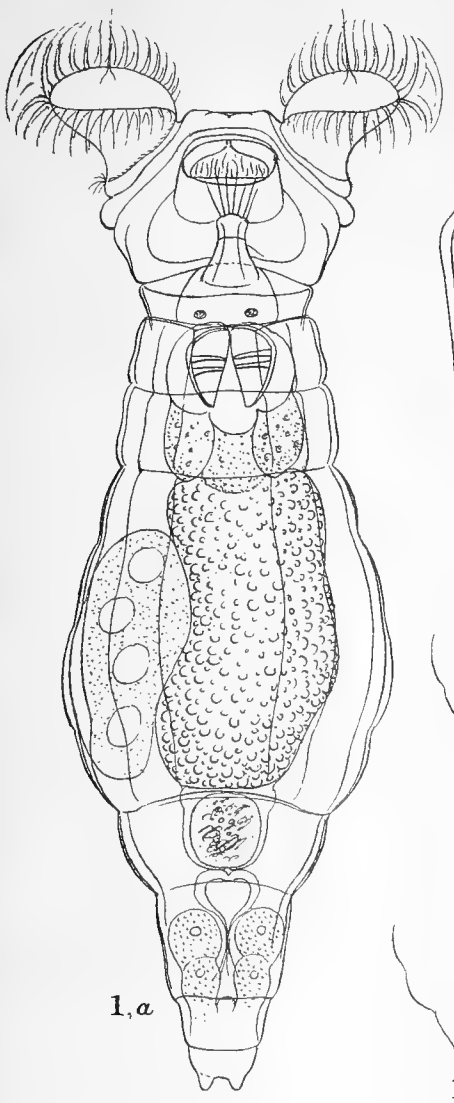
Plate V.

18. *Pseudœcistes rotifer*, Stenroos.
    a, the animal swimming.
    b, teeth of one jaw.
19. *Stephanops tenellus*, Bryce.
    a, dorsal view.
    b, lateral view.
20. *Rotifer trisecatus*, Weber.
    a, jaw.
    b, foot, from ventral side.
    c, foot, lateral view of penultimate segment and spurs.
21. *Philodina macrostyla*, Ehr. Rostral tip, to show pairs of tactile setæ.
22. *Rotifer tardus*, Ehr. Head, showing central setæ.
23. *Rotifer vulgaris*, Schrank. Head, showing central setæ.
24. *Albertia intrusor*, Gosse.
    a, dorsal view.
    b, lateral view.
    c, lateral view of young.
    d, dorsal view of young.

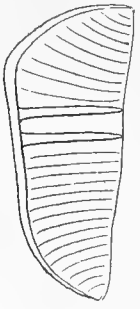
Plate VI.

25. *Notommata pumila*, n. sp., Rousselet.
    a, lateral view, drawn by F. R. Dixon-Nuttall.
    b, jaws, after drawing by Mr Rousselet.
    c, toes, dorsal view.
26. *Proales daphnicola*, Thompson.
    a, lateral view, head applied to skin of worm.
    b, five examples adhering to one worm.
    c, jaws.
27. *Colurus tesselatus*, Glascott.
    a, dorsal view.
    b, lateral view.
28. *Plœsoma*, sp.?
    a, probably *P. triacanthum* (Bergendal).
    b, larger species, also with three dorsal spines, and two additional lateral spines.

MURRAY: THE ROTIFERA OF THE SCOTTISH LOCHS.—PLATE I



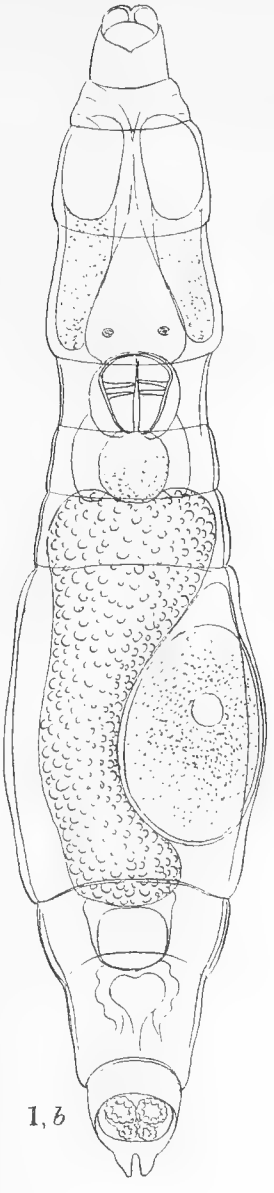
1, *a*



1, *c*

1, *d*

1, *e*



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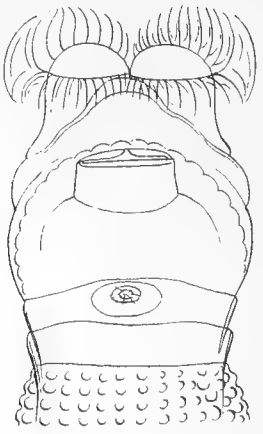

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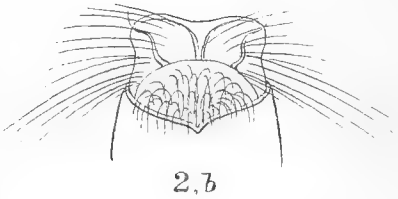
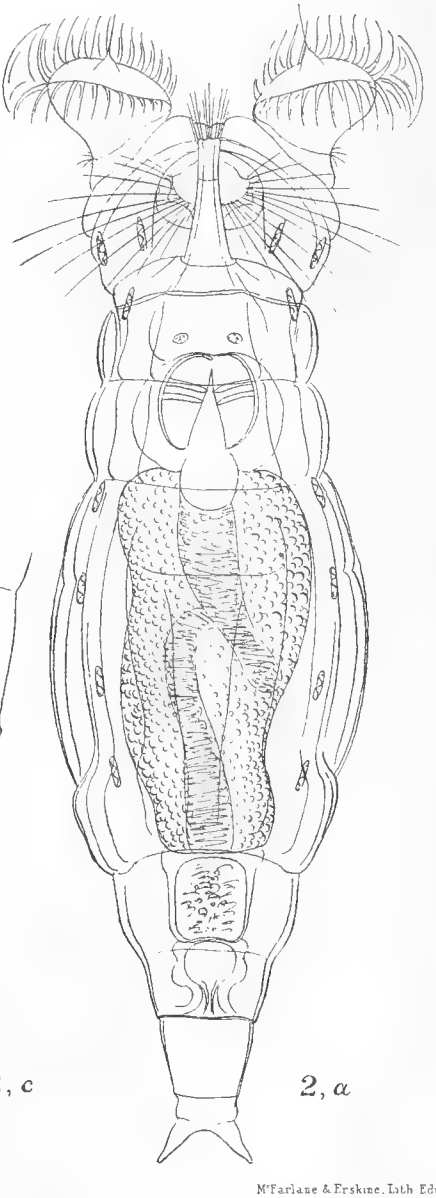
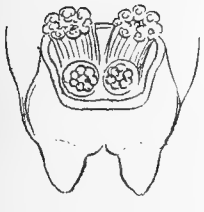


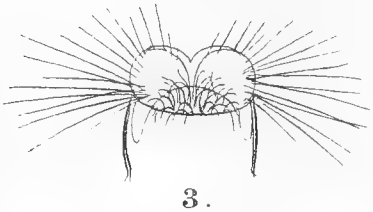
2, *b*



2, *a*



1, *f*



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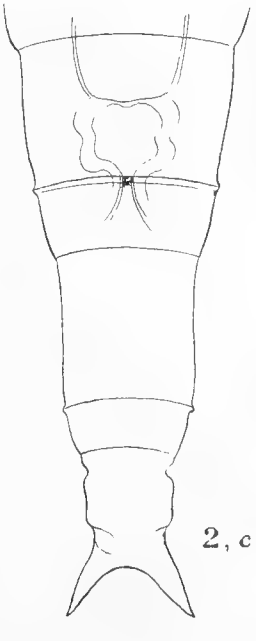
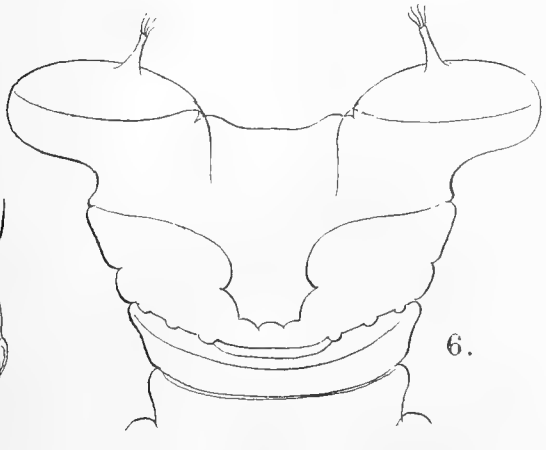


2, *c*



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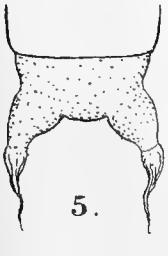
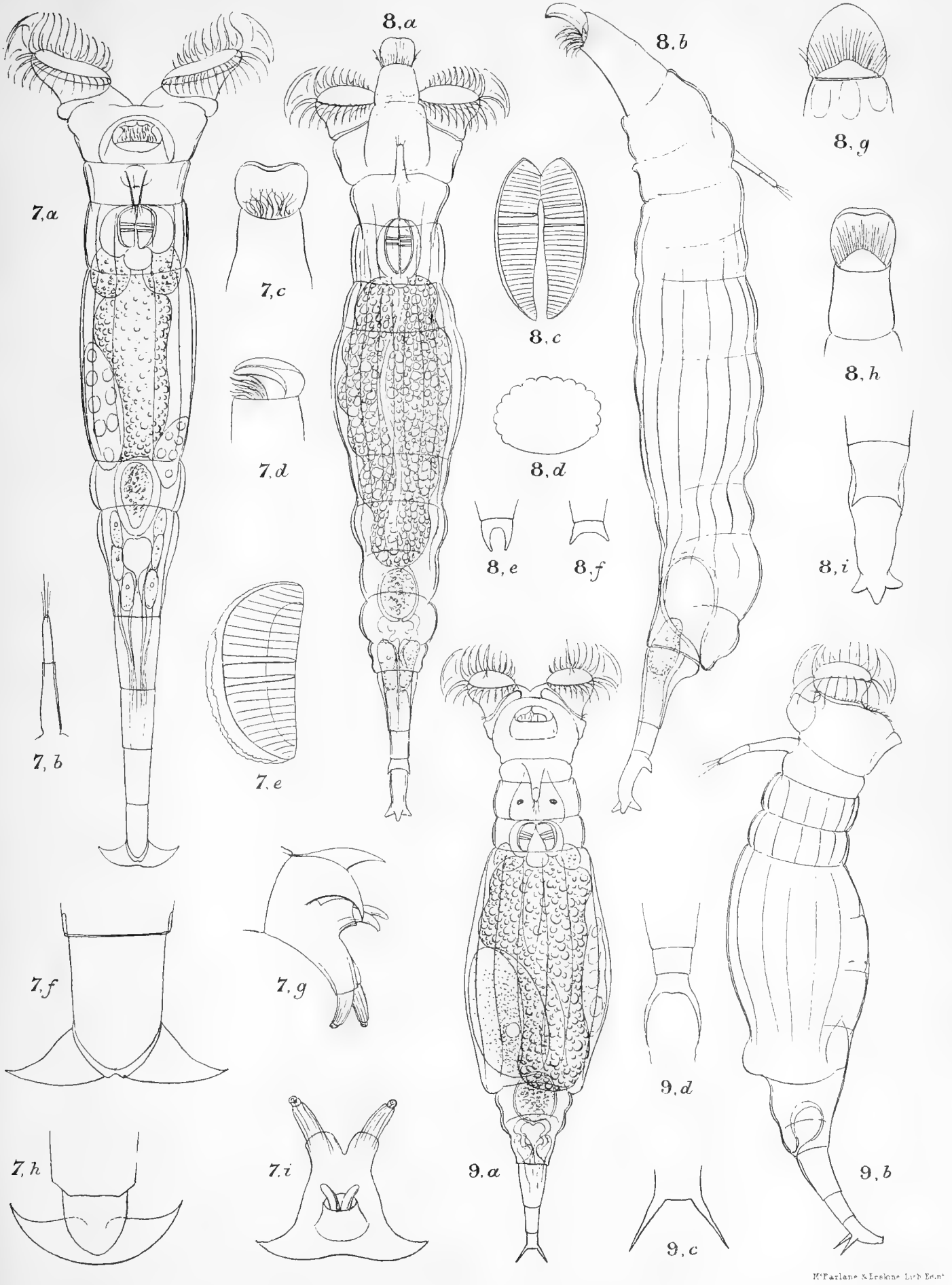


5.

M'Farlane & Erskine, Lith Edin.r

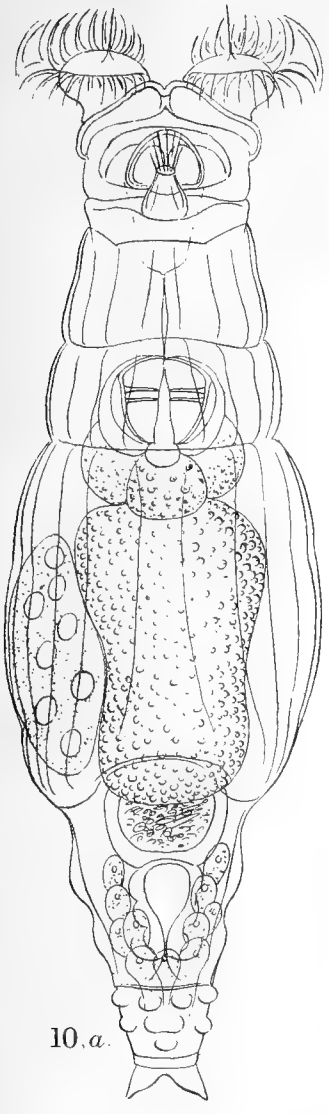
1, PHILODINA FLAVICEPS, n. sp. Bryce. 2, PHILODINA BREVIPES, Murray. 3, PHILODINA ACUTICORNIS, Murray.
4, CALLIDINA CRENATA, Murray. 5, CALLIDINA SCARLATINA, Ehr. 6, CALLIDINA MAGNA, Plate.

MURRAY: THE ROTIFERA OF THE SCOTTISH LOCHS.—PLATE II

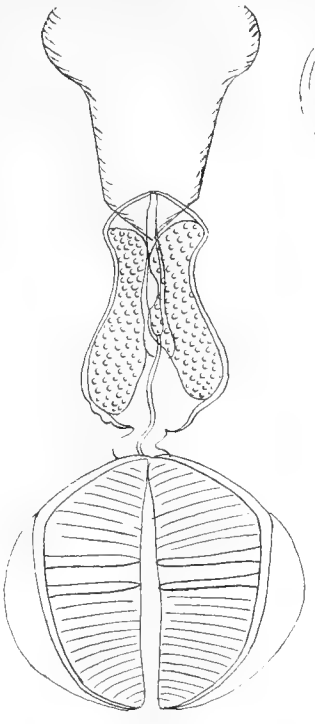


7. PHILODINA HAMATA, n. sp. 8. CALLIDINA NATANS, n. sp. 9. PHILODINA ACUTICORNIS, Murray.

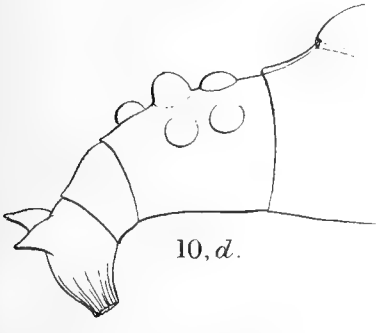
MURRAY: THE ROTIFERA OF THE SCOTTISH LOCHS.—PLATE III.



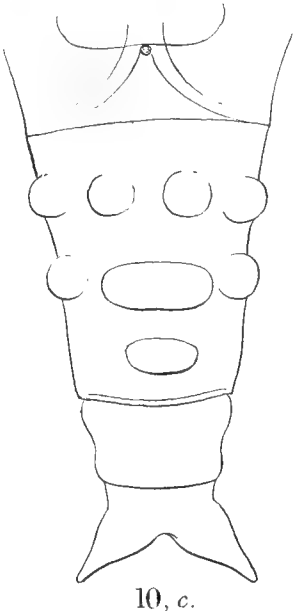
10, *a*.



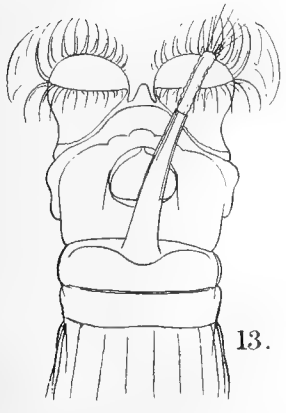
10, *b*.



10, *d*.



10, *c*.



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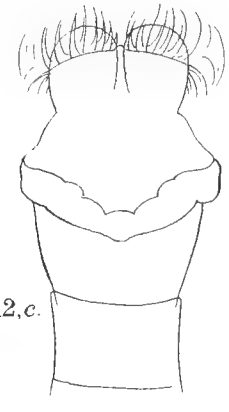
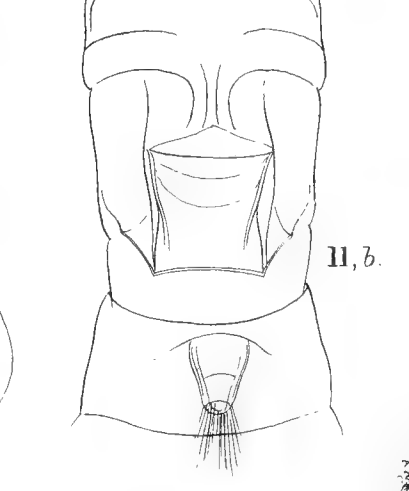
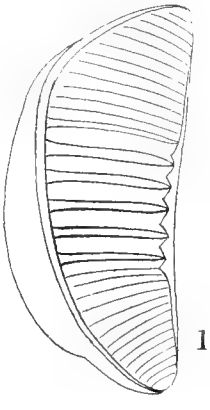


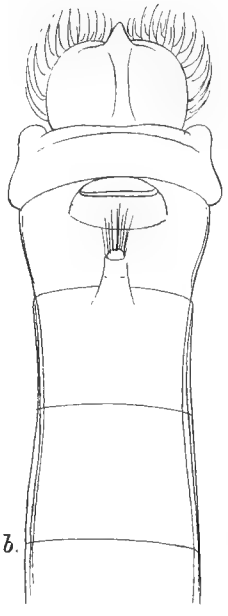
12, *c*.



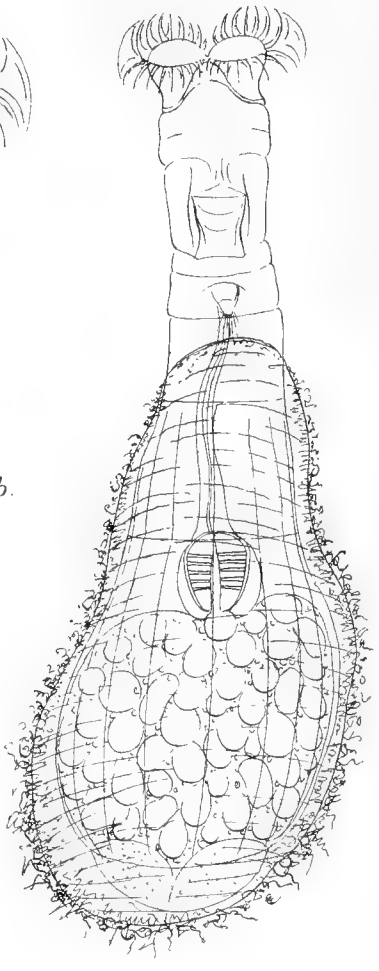
11, *b*.



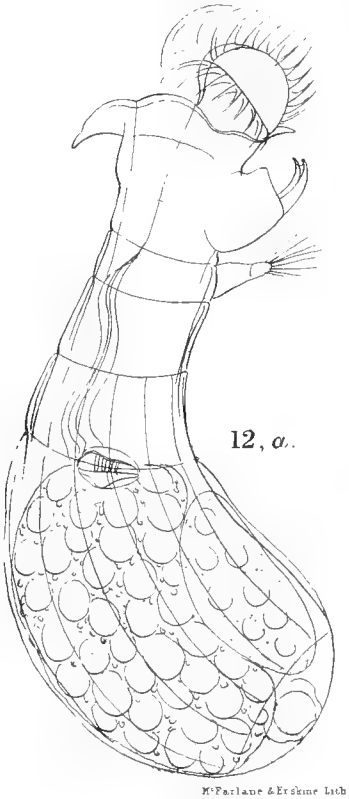
11, *c*.



12, *b*.



11, *a*.

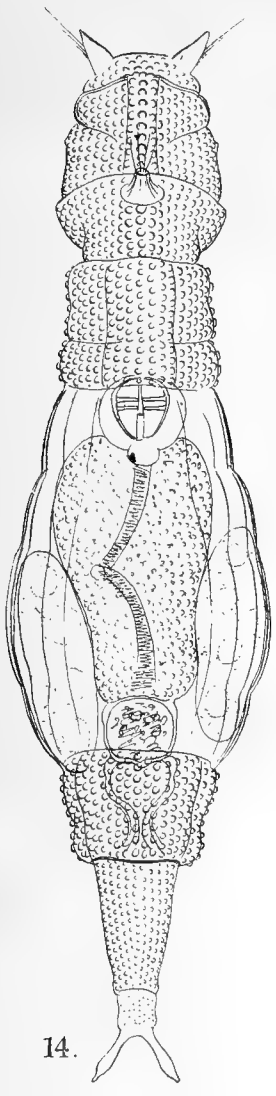


12, *a*.

M^c Farlane & Erskine Lith Edin^r

10 CALLIDINA HABITA, var. BULLATA, n. var. 11, C. LONGICEPS, n. sp. 12, C. PUSILLA, Bryce, var.
13, CALLIDINA HEXODONTA, Bergendal.

MURRAY: THE ROTIFERA OF THE SCOTTISH LOCHS.—PLATE IV.



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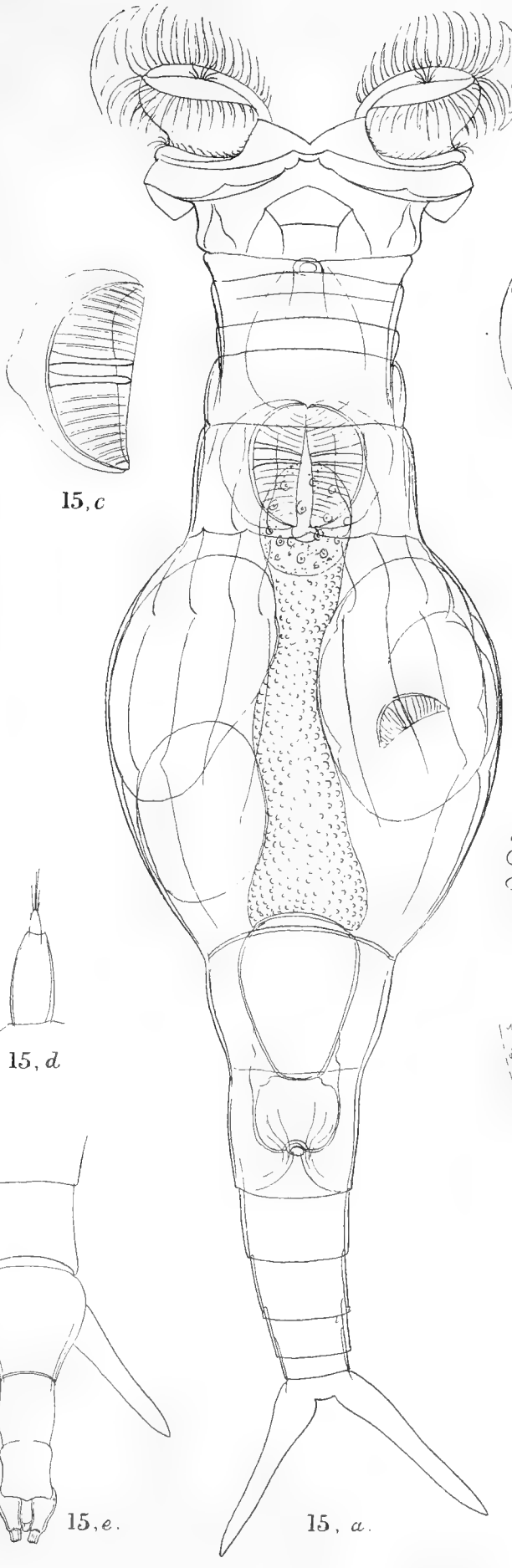
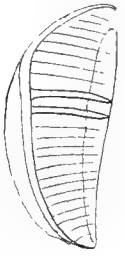
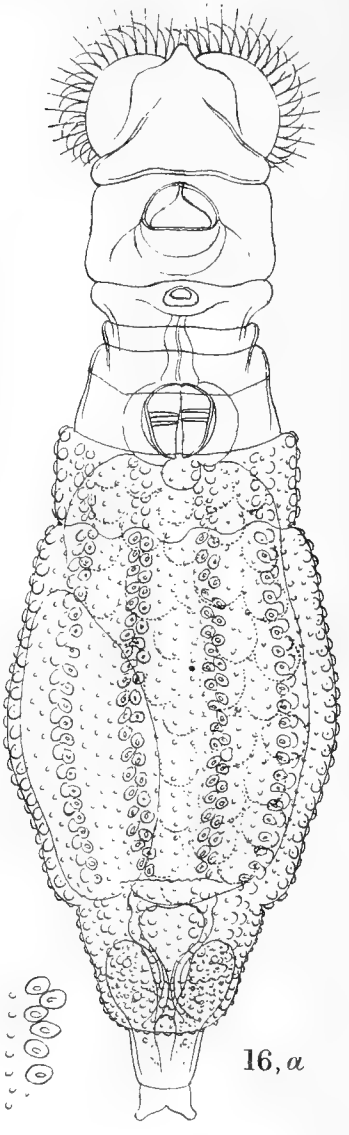


15, *a*.

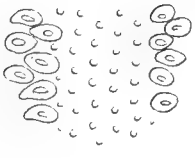
15, *c*



16, *b*.

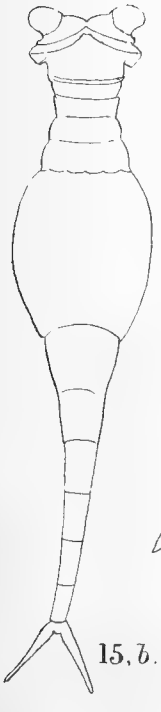


16, *a*



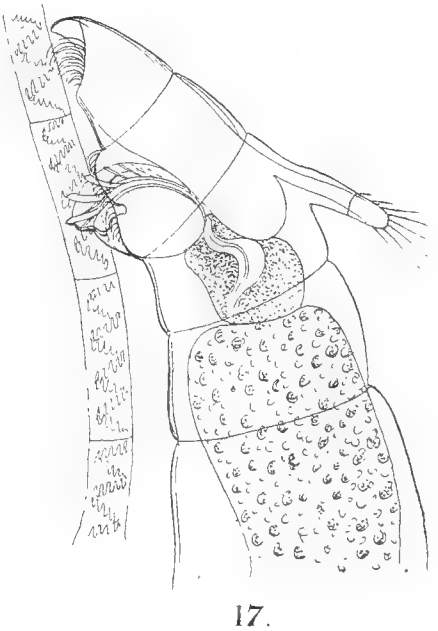
16, *c*.

15, *d*



15, *b*.

15, *e*.

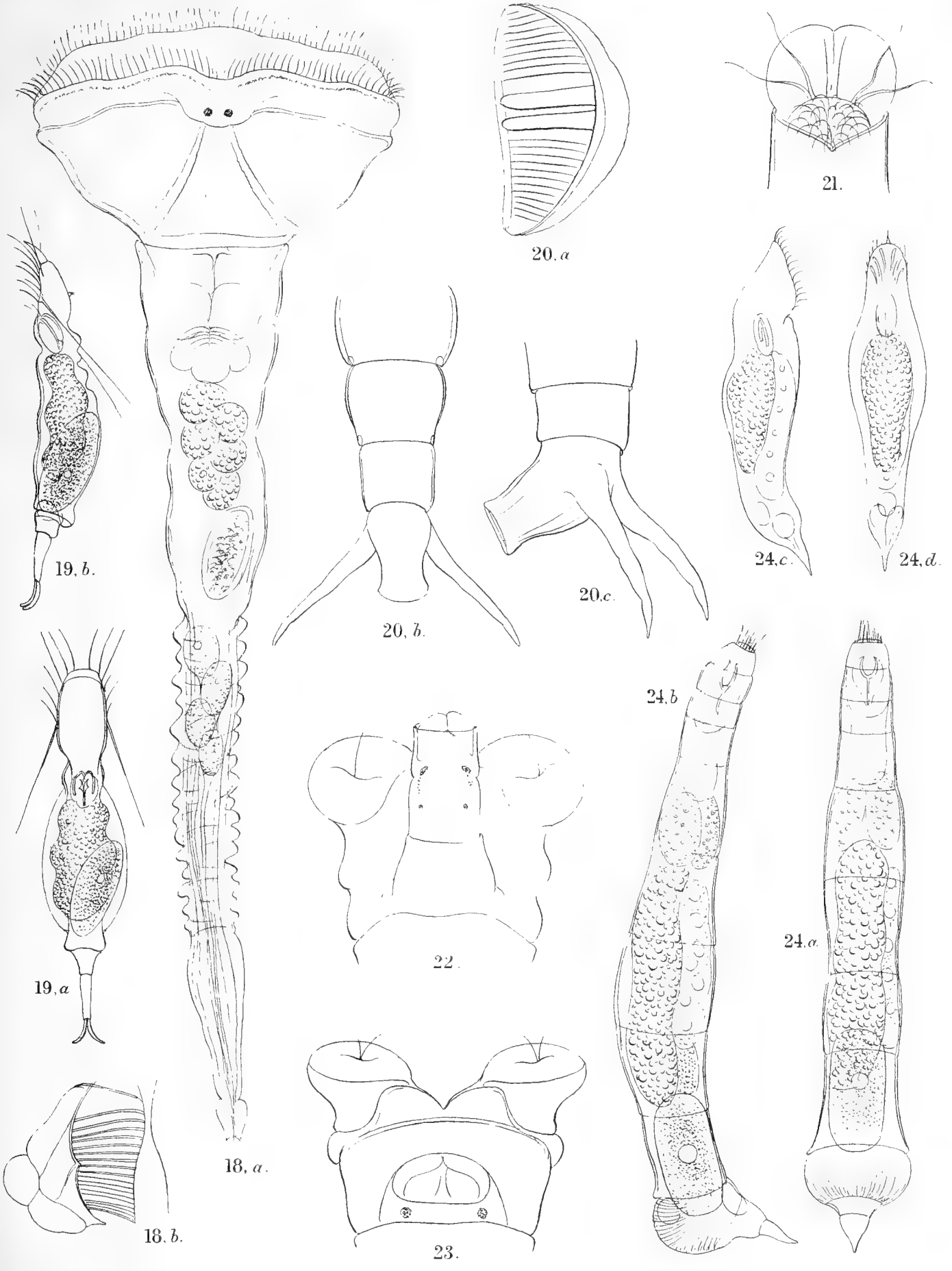


17.

M'Farlane & Erskine Lith Edin.r

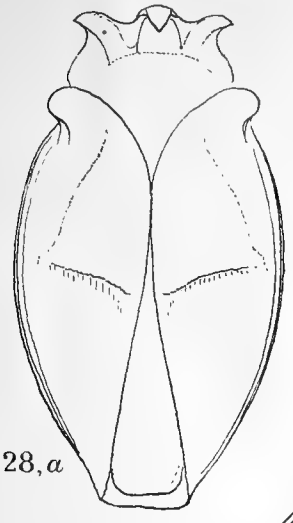
14, ADINETA TUBERCULOSA, Janson. 15, CALLIDINA SOCIALIS, Kellicott. 16, CALLIDINA ASPERA, Bryce.
17, MICRODINA PARADOXA, Murray.

MURRAY: THE ROTIFERA OF THE SCOTTISH LOCHS.—PLATE V.

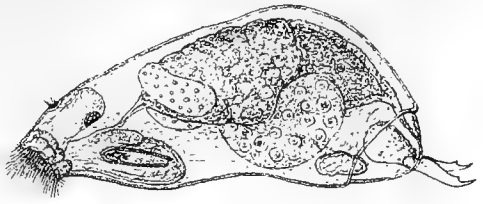


18, PSEUDOECISTES ROTIFER, Stenroos. 19, STEPHANOPS TENELLUS, Bryce. 20, ROTIFER TRISECATUS, Weber.
21, PHILODINA MACROSTYLA, Ehr. 22, ROTIFER TARDUS, Ehr. 23, ROTIFER VULGARIS, Schrank. 24, ALBERTIA INTRUSOR, Gosse.

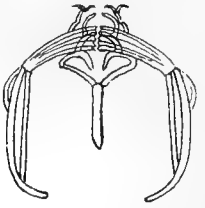
MURRAY: THE ROTIFERA OF THE SCOTTISH LOCHS.—PLATE VI.



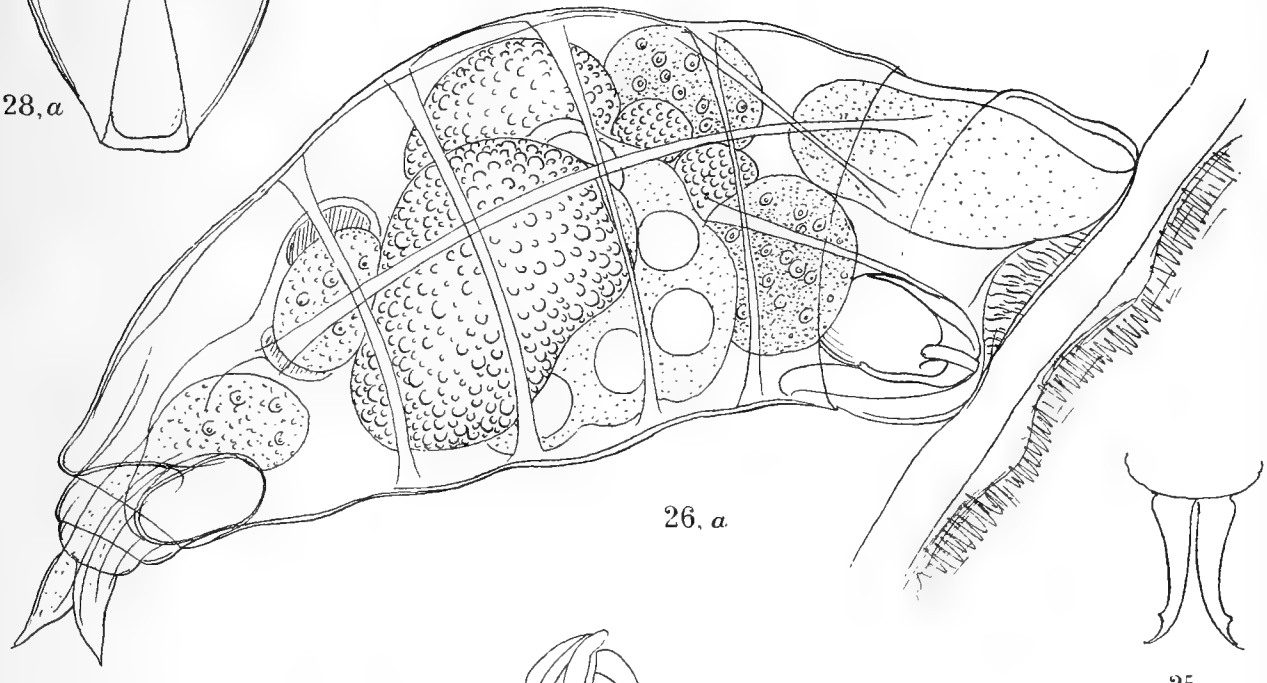
28, *a*



25, *a*.

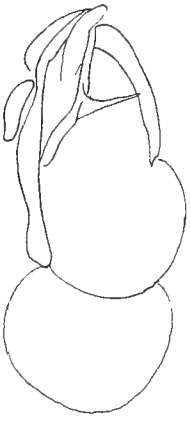


25, *b*.

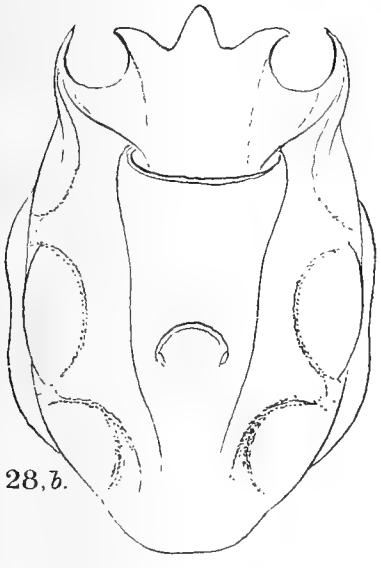


26, *a*

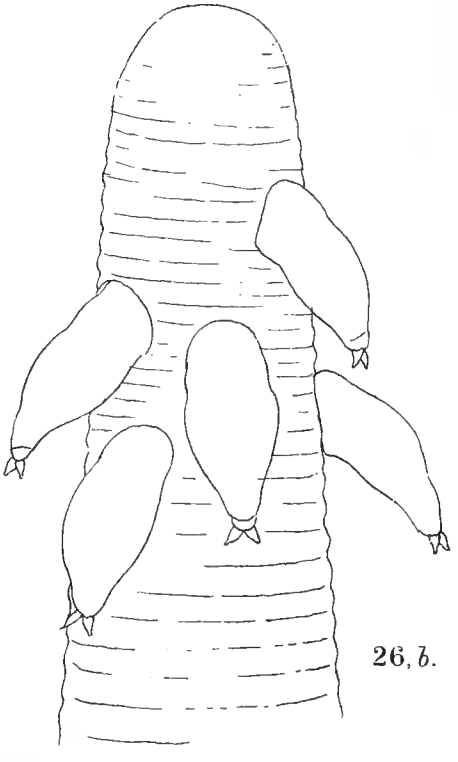
25, *c*.



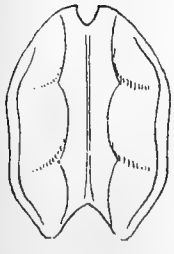
26, *c*.



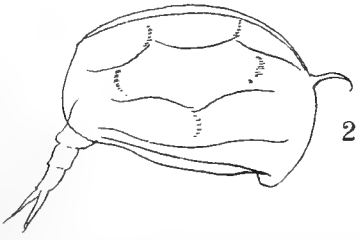
28, *b*.



26, *b*.



27, *a*



27. *b*.

M.cFarlane & Erskine Lith Edin.r

25, NOTOMMATA PUMILA, n. sp. Rousselet. 26, PROALES DAPHNICOLA, Thompson. 27, COLURUS TESSELATUS, Glascott
28, PLŒSOMA TRIACANTHUM, Bergendal?

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XXII. Part 2.	0 10 0	0 7 6			
,, Part 3.	1 5 0	1 1 0			
XXVII. Part 1.	0 16 0	0 12 0			
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,, Part 4.	1 0 0	0 16 0			
XXVIII. Part 1.	1 5 0	1 1 0			
,, Part 2.	1 5 0	1 1 0			
,, Part 3.	0 18 0	0 13 6			
XXIX. Part 1.	1 12 0	1 6 0			
,, Part 2.	0 16 0	0 12 0			
XXX. Part 1.	1 12 0	1 6 0			
,, Part 2.	0 16 0	0 12 0			
,, Part 3.	0 5 0	0 4 0			
,, Part 4.	0 7 6	0 5 8			
XXXI.	4 4 0	3 3 0			
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,, Part 2.	0 18 0	0 13 6			
,, Part 3.	2 10 0	1 17 6			
,, Part 4.	0 5 0	0 4 0			
XXXIII. Part 1.	1 1 0	0 16 0			
,, Part 2.	2 2 0	1 11 0			
,, Part 3.	0 12 0	0 9 6			
XXXIV.	2 2 0	1 11 0			
XXXV.*Part 1.	2 2 0	1 11 0			
,, Part 2.	1 11 0	1 3 6			
,, Part 3.	2 2 0	1 11 0			
,, Part 4.	1 1 0	0 16 0			
XXXVI. Part 1.	1 1 0	0 16 0			
,, Part 2.	1 16 6	1 7 6			
,, Part 3.	1 0 0	0 16 0			
XXXVII. Part 1.	1 14 6	1 5 6			
,, Part 2.	1 1 0	0 16 0			
,, Part 3.	0 16 0	0 12 0			
,, Part 4.	0 7 6	0 5 8			
XXXVIII. Part 1.	2 0 0	1 10 0			
,, Part 2.	1 5 0	0 19 0			
,, Part 3.	1 10 0	1 3 0			
,, Part 4.	0 7 6	0 5 8			

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